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NEWLY DISCOVERED BREEDING PLACES OF PHILIPPINE SEA BIRDS.

By DEAN C. WORCESTER.

Gulls and terns in considerable variety have long been known from the Philippines. Brown boobies, too, have been recorded by various ornithological collectors, but only one specimen of the red-legged booby, and that an immature individual, had been collected in the Islands prior to June 25, 1910, on which date, when crossing the Sulu Sea between Kalusa Island and Puerto Princesa, Palawan, I saw a large flock of these birds hovering over a school of fishes. I had the captain change course slightly so as to take the steamer near them, but they dispersed before us. Several individuals flew within long shotgun range of the ship and I had the good fortune to bring down a fine, adult specimen which fell into the sea but was recovered by stopping the steamer and lowering a boat.

On July 13, 1910, on which date I was exploring the islands in Green Island Bay on the east coast of Palawan when I was heading for Reef Island, I saw, on the starboard bow, a sandbar rising not more than a meter above the sea, the tide at that time being full. While I was examining it through my field glasses, a large flock of terns suddenly rose from it, and after circling for a few moments settled again. Although the breeding season for most birds was then well over, I was at a loss to understand why these terns should be gathered in such numbers upon a perfectly bare sandbar unless they had eggs or young there, so ordered the steamer stopped and a boat lowered, and proceeded to investigate.

The terns did not again take wing until we were close in shore, and then refused to leave the immediate vicinity of the reef, circling close over our heads. Nearly all of the individuals were black-naped terns, *Sterna melanauchen* Temminck, but by pure accident I killed a single specimen of the oriental roseate tern, *Sterna gracilis* Gould, which had never before been taken in the Islands. By watching sharply, I was then able to pick out and kill two additional specimens, recognizing them in flight by their red legs.

We found numerous eggs on the reef. They were deposited singly or in pairs in slight depressions in the sand, lined in a number of instances with bits of sea shell and of white coral.

So far as I am aware, this was the first time that terns have been found breeding in the Philippines.

On August 24, 1910, I joined Governor-General Forbes and the Secretary of War on board the steamer *Rizal* at Capiz, Panay, and was greatly interested to learn that on their way from Jolo to Puerto Princesa they had landed on Bankoran Island in the middle of the Sulu Sea, finding great numbers of brown and red-legged boobies and some of the greater frigate birds, as well as a few terns. They had obtained specimens of all the species observed and had put them in cold storage so that I was able to make positive identifications. They told me that there were many nests in the trees and on the ground, but that only one egg had been obtained. Upon examination I found that the egg was obviously that of a booby, but whether of a brown or a red-legged booby it was impossible to say.

On September 16, 1910, I had occasion to leave Manila on a trip to the west coast of Palawan and subsequently passed through Balabac Strait and sailed north along the chain of islands and shoals which extends in a generally northeasterly direction through the Sulu Sea. Bankoran Island was reached early on the morning of September 22. Fortunately the weather was calm and we were able to land at the southwestern end of the island at 6 o'clock. From the steamer we had seen immense flocks of boobies circling about the island, which is covered throughout nearly its entire extent with trees, but has at its western end sand-spits, partially overgrown with grass and bushes, while at low tide rough masses of coral rag are left exposed by the receding water.

We at once discovered that the red-legged boobies, *Sula piscator* (Linnaeus), were nesting in the trees, while the brown boobies, *Sula leucogastra* (Boddaert), were nesting on the ground. A few moments' observation sufficed to show that a number of red-legged boobies, which we found in, or close to, nests upon the ground, were not their owners as we had at first supposed, but were stealing nesting material from them in the absence of the brown boobies which had built them.

With very few exceptions the nests on the ground contained no eggs.

We soon discovered this to be due to the fact that two boat loads of Moro egg-hunters had on the previous afternoon removed every egg from the ground nests. Their boats were still anchored on the shoal to the north of the island and were found to contain both boobies' eggs and sea turtles' eggs in large numbers.

Apparently they had been too lazy to climb the trees after the eggs of the red-legged boobies, some of which we were, therefore, able to collect.

The Moros assured us that by noon there would be plenty of fresh eggs in the nests of the brown boobies, and this proved to be the case. The boobies of both species were so tame that we experienced no difficulty in catching alive as many as we needed for specimens, and we were also able to secure a very interesting series of photographs, and to observe closely the nesting habits of the birds of both species. The male and female brown boobies were readily distinguished by the fact that the former had the bare skin at the base of the bill and on the throat dark blue, while in the latter it was bright lemon yellow.

The ground nests of the brown boobies were made of bits of rotten wood, dead leaves, small branches, and twigs to many of which green leaves were still attached. In fact we saw the birds breaking such twigs from the trees. The female usually remained sitting bolt upright in her nest, while the male brought nesting materials which he turned over to her. These she promptly put in place, not infrequently lifting and putting down repeatedly a given leaf, twig or bit of punky wood until she had placed it just to suit her. Occasionally the materials brought by male birds were rejected, and as a rule when the latter endeavored to put any material in place in the nest, as was sometimes the case, it was thrown out by the females, which were evidently determined to construct their houses in strict accordance with their own ideas and to keep the male birds under proper discipline.

In many cases the nests were in close proximity to each other and the male birds were constantly trying to steal materials from other nests. This led to vigorous vocal protest from the rightful owners and not infrequently to rough-and-tumble fights as well. The fights were all of short duration and quite bloodless. In no instance could we see that one booby really injured another.

The red-legged boobies not only stole nesting materials from their brown relatives, but quarreled shamefully among themselves.

Every bird which attempted to fly through the air with a fairly sizeable branch in its mouth was set upon by half a dozen others, which, in their efforts to make it drop its burden frequently drove it to the ground where it was vigorously mauled until it relaxed its hold upon the branch. Some other bird then attempted to fly off with it and was set upon in turn. These contests seemed always to end when a lucky individual succeeded in getting to its nest with the coveted branch.

Both brown and red-legged boobies rose readily from the ground, and flew among the trees with greater skill than one would have expected them to display, but if caught in grass or brush they were very helpless.

Only a single frigate bird was observed, and this individual promptly left the island on our arrival.

The eggs of the two species were indistinguishable. Each had a white, chalky outer layer, with a harder underlying layer which was very light blue in color. The female brown boobies were most reluctant to leave nests which contained eggs, and in some instances would not do so until actually pushed off. Upon the near approach of any member of our party, females which were sitting upon eggs manifested their uneasiness and nervousness by croaking and by picking up and laying down bits of nesting material. In a number of instances they displayed great courage, staying by their eggs and pecking vigorously at the hands of those who attempted to dislodge them. When taking photographs with a Graflex camera I had no difficulty in getting within four feet of nesting birds.

In the course of the morning a fresh breeze sprang up and the tide which had been low when we landed rose so that we could not reembark on the windward side of the island but had to send the boat around to the leeward side. We returned to the steamer at a quarter past twelve and I requested the captain to sail for Tub-bataha, thinking we might find sea birds on one or another of the several small islands which rise from this extensive shoal. The captain, however, objected, as we should necessarily have arrived at night. The position of Tub-bataha is not definitely known, and there are a number of bad outlying shoals, so that he did not deem it prudent to stand on and off in the dark. As an alternative he suggested that we visit Macander Reef, where, according to the sailing directions, sea birds had been seen in large numbers.

At 4.30 in the afternoon the steamer changed course sharply to the south. Macander Reef had been sighted from the masthead considerably to the south of the point where it is shown on the chart. We reached it in half an hour and found it to be a mere sandbar about 200 meters long by 150 wide, rising not more than two meters above the water. It is surrounded by an extensive shoal over which we were forced to wade and is absolutely devoid of vegetation. Drift wood lodged at its highest point showed that the waves break clean over it in very heavy storms, in spite of the shoal which one would suppose would prevent any such result.

While still at a considerable distance, we saw through our glasses flocks of birds flying over the reef, and regiments of brown boobies sitting in long lines upon the shore. As we drew nearer we made out groups of northern Brown's terns, *Sterna berardii* Boiss. with young

which were big enough to run about freely and to take to the water upon our nearer approach. Upon walking up the steeply shelving sand beach we beheld a wonderful sight. Enormous numbers of sooty terns, *Sterna fuscata* Linnaeus, were standing on the sand in great groups, containing fully adult birds in breeding plumage, immature birds which were dark brown or black with some white-spotted feathers, young still partially in the down but with wings feathered out, and freshly hatched chicks colored so like the sand about them that when they crouched flat upon it, with outstretched necks and extended wings, they disappeared from view before one's very eyes. Eggs were scattered around in large numbers, but many of them were bad ones which had failed to hatch. Large solemn-looking chicks of the brown booby, still in the down, but apparently heavier than their parents, were sitting about in considerable numbers. There were also numerous breeding groups of northern Bergius' terns, with small chicks and eggs, in addition to the groups previously referred to which contained young big enough to run about actively.

Immediately after landing we observed several noddy terns, *Anous stolidus* (Linnaeus). A shot fired at one of these caused thousands upon thousands of birds to take wing. We worked actively until dark, taking photographs and securing specimens of the several species of birds in different plumages, and then returned to the ship heavily laden with valuable ornithological spoils.

I could not make up my mind to leave the reef without taking additional photographs. The light at the time of our arrival was very weak and it had faded rapidly so that I feared that many of the plates which we had exposed would be failures. Therefore, we stood on and off through the night. The current drifted us some four miles to the northward but we picked up the reef from the masthead at 5.30 the following morning.

On the afternoon of our arrival the birds had been kept in constant motion by the sailors who were running about in search of turtles' eggs, and by other members of our party who were looking in vain for insects or plants.

Our two ornithological collectors remained on board to care for the material obtained the previous day, and I limited the landing party to the Director of the Bureau of Science, one Filipino collector, two sailors, and myself.

With difficulty the sailors were convinced that it was to their interest to sit down and *keep still*. I then got an opportunity to obtain some very interesting photographs. There were a few red-legged boobies on the reef, but so far as I could see they were not breeding. A number of brown boobies had deposited their eggs in hollows in the sand, as there was no nesting material available on the island, except a little

decayed wood laboriously torn from the few tree trunks which had drifted on to reef. One enterprising female had actually dug out enough punk to make a hollow in a log and had deposited her two eggs therein.

Although the number of eggs laid by one bird seemed to be quite uniformly two, in only one instance did I see a brown booby caring for more than one young one. Photographs of the boobies could be taken at any desired distance.

I found it possible to walk directly among the sooty terns. Although they at first flew away from my immediate vicinity they promptly returned again. The nesting groups of the northern Bergius's terns proved much more difficult to approach, but by the exercise of a little care and patience I was able to get quite satisfactory photographs of one such group. I had never previously known that the birds of this species had the power of erecting the black feathers of the head so as to form conspicuous crests. One of the photographs reproduced (Plate V, figure 1) shows clearly that this is the case. Shortly before 10 o'clock a strong breeze sprang up from the southwest. Immediately every sooty tern on the island, except a few of the downy chicks, faced the wind which proved to be the forerunner of a heavy shower. When the rain was almost upon us Doctor Freer fired at a frigate bird. Thousands of terns took wing but instead of circling widely as they had previously done when alarmed, held themselves stationary in the air, hovering for a moment over their eggs and young, but almost immediately dropping upon them again. After the rain began to fall the birds which were incubating eggs refused to leave them until actually pushed away, pecking savagely at the hands of intruders.

I greatly regretted the coming of this shower as I wished to secure more photographs showing the habits of the big booby chicks. When I first landed I saw a number of chicks stretched out flat on the sand with wings extended and heads doubled back under their necks. I thought at first that they were dead but found upon touching them that they were very much alive. I then jumped to the conclusion that they were trying to hide, as did the little terns, but after further observation convinced myself that they were merely sleeping. In each instance when I attempted to turn the camera on them at short range they woke up and hopped awkwardly away.

As there was no sheltering vegetation of any kind the heat upon the reef became intense as soon as the sun got well up. The booby chicks promptly took advantage of the shadows cast by older birds, often coming up from behind and flattening themselves on the sand with their heads stretched under the tails, or even between the legs, of their mothers.

As it was obviously unsafe to remain on the reef a moment after the sea began to rise, we reluctantly turned our backs on one of the most

extraordinary scenes which I have ever witnessed, waded out to the edge of the shoal, took the boat to the steamer, and sailed for Cavilli Island, where we arrived the next morning shortly after daylight.

Just before we left Macander Reef three man-of-war birds had suddenly appeared, hurrying in before the on-coming storm, and Doctor Freer had succeeded to our great satisfaction in killing two of them. When discussing our good luck on board the steamer the following evening it was suggested that it only remained to find frigate birds and petrels breeding on Cavilli!

Just as I was going down to breakfast in the morning my son came running to tell me that frigate birds were hovering low over the steamer, and upon ascending to the upper bridge deck I discovered several individuals within easy range. Within the next few moments I shot nine, of which eight were recovered. By this time we could see frigate birds in large numbers flying over Cavilli Island, which like Bankoran Island, is heavily forested. Furthermore, we saw in increasing numbers, birds which we at first took for petrels, and it really began to look as if the wish which we had expressed the night before was to be fulfilled.

Immediately after breakfast we landed in the ship's small boat, having as usual to wade for a long distance over a shoal before reaching the beach. On our way we shot a number of specimens of the above mentioned small petrel-like birds, which proved to be of the genus *Micranous*. No representative of this genus had ever previously been recorded from the Philippines. Comparison with specimens in the United States National Museum shows that this is a species closely allied to *Micranous leucocapillus* (Gould). It is described in this Journal as *Micranous worcesteri* McGregor, sp. nov.¹

Upon arrival at the beach, Mr. McGregor, the government ornithologist, set off rapidly for a sand spit at the east end of the island where he expected to find *Micranous* breeding, while the rest of us went directly into the forest where I hoped to be able to kill some of the frigate birds which were flying just above the tree tops. To my amazement, I found countless thousands of *Micranous* nesting in the trees. A single cartridge, loaded with a small charge of dust shot, brought down seven perfect specimens. Sailors were sent up the trees but found most of the nests empty. We had arrived too late to get eggs in any numbers. An adled egg was, however, obtained, and we also secured several well-grown nestlings which were photographed at short range. The frigate birds had apparently finished nesting but immature birds were present in large numbers.

Red-legged boobies were nesting in the trees, but we did not see a single brown booby on the island.

¹ This Journal, Sec. D (1911), 6,

Male frigate birds, *Fregata aquila* (Linnaeus), were flying about with their scarlet throat pouches puffed out like children's toy rubber balloons, and a photograph was secured of a fine male which came down wounded and kept its throat pouch partially inflated.

Shortly before noon we returned to our steamer taking with us a splendid series of specimens of the frigate bird and of *Micranous*, and also a number of wood rats which were extraordinarily abundant.

During the lunch hour we ran as near as possible to the Arena Islands of which there are two rising from an extensive shoal. Here we found two frigate birds; also a number of brown boobies nesting on the ground. We decided, however, that it was best to return to Cavilli Island and collect carefully selected specimens of frigate birds in order to complete a series showing fully the immature and adult plumages.

This we were able to do. A wounded bird which fell into the sea near shore served to attract others in large numbers so that we could select our specimens at will. We also obtained a good series of immature red-legged boobies. These birds displayed a great interest in us both when we approached and when we left the island and in several instances attempted to alight upon us or our boat.

Just before dusk as we were leaving for the steamer we witnessed an extraordinary scene. Large numbers of red-legged boobies which had apparently been fishing all day began to return, bringing fish to their nesting mates and to their young. The frigate birds promptly formed a skirmish line and, singly or in pairs, attacked all comers, compelling them to give up their fish. Some of the boobies, possibly sophisticated individuals which had learned wisdom by experience, actually handed their fish over to the frigate birds and so escaped without much drubbing, but less experienced or more obstinate individuals which at first refused to disgorge were vigorously punished until they changed their minds and threw up their fish which were most adroitly caught in the air by their piratical enemies. In one instance two frigate birds set upon a booby, one of them attacking him from above and the other flying below to catch the fish which he dropped, and getting five out of seven. Soon the incoming boobies began to arrive in flocks and the frigate birds were not able to set upon them all, so that many individuals got through to the island. Once among the trees they were left in peace.

A trip should be made to Cavilli Island earlier in the season when *Micranous* and possibly also the frigate birds will be found mating.

On June 23, 1911, I sailed from Manila with Governor-General Forbes and others on a trip to the Calamianes Islands, Palawan, the Sulu Archipelago, and Mindanao. On the evening of June 28 we left Puerto Princesa for Sibutu and Sitanki, and as the weather was unusually calm decided to go by way of Tub-bataha Reef which I had never previously succeeded in visiting.

Early the following morning we reached that reef finding, near its extreme northern end, a low flat sandy island called Usong. It is some 400 meters long by 150 wide. The sailing directions state that this island has upon it a rock 20 feet high, as well as some trees, but this is not the case. A boat belonging to some turtle hunters was anchored just off the beach and they had erected on shore a small hut thatched with nipa-palm leaves. Doubtless some timid navigator passing the reef at a distance mistook such a house for a rock.

There was no vegetation on the island except a few plants of pursley.² There can never have been any trees there as the waves evidently dash clear across it during violent storms.

Brown boobies in enormous numbers were nesting in the sand.

Near the center of the island there was a large colony of black and white boobies, which we at first mistook for red-legged boobies. Presently, however, the Governor-General called my attention to the fact that they were not red-legged. On the contrary their legs, feet, toes, and nails were of a very dark lead color. Indeed they were almost black. Their bills were dull yellow and the bare skin at their bases was of the color of that of the feet and legs. I have since identified these birds as belonging to the species *Sula cyanops* (Sundev.), a species not previously recorded from the Philippines.

There were numerous noddy terns, *Anous stolidus* (Linnaeus), on the island and they were nesting on the ground among the pursely plants. We did not find any of them nesting on the bare sand.

There were also a number of large and interesting groups of northern Bergius's terns. The egg hunters had gathered the terns' eggs into heaps preparatory to carrying them off. I compelled these misguided individuals to leave the birds undisturbed throughout the day, and within a short time the terns had scattered the heaps of eggs over the sand and were incubating as busily and contentedly as if nothing had happened to disturb them.

After gathering numerous typical eggs for the collection of the Bureau of Science, shooting a number of fine specimens of the breeding birds, and taking a series of photographs, we sailed to the south skirting the eastern edge of Tub-bataha Reef until the small island on Black Rock Reef hove in sight. Meantime we had passed near a second small sandy island on Tub-bataha Reef. It seemed to be covered with brown boobies, as was the island on Black Rock Reef. We landed on the latter, finding numerous nesting brown boobies and northern Bergius's terns, but nothing else.

² *Portulaca oleracea* L.

ILLUSTRATIONS.

(Photographs by Worcester and Cortez.)

PLATE I.

Brown booby; *Sula leucogastra* (Boddaert).

PLATE II.

- FIG. 1. Female brown booby with two large chicks. Maeander Reef.
2. Brown booby with nest and egg. Bankoran Island.

PLATE III.

- FIG. 1. Nest and egg of red-legged booby, *Sula piscator* (Linnæus). Bankoran Island.
2. Red-legged boobies nesting. Bankoran Island.

PLATE IV.

- FIG. 1. Sooty terns, *Sterna fuscata* (Linnæus). Maeander Reef.
2. Group of sooty terns nesting. Maeander Reef.

PLATE V.

- FIG. 1. Northern Bergius's terns, *Sterna bergotis* Bangs, nesting. A sooty tern in the foreground. Maeander Reef.
2. Eggs and young of northern Bergius's tern. Maeander Reef.

PLATE VI.

- FIG. 1. Boobies on Usong Island. Tub-bataha Reef.
2. A group of sooty terns, chiefly immature. Boobies in the background.

PLATE VII.

- FIG. 1. Young of *Micranous worcesteri* McGregor, sp. nov. in nest.
2. Bankoran Island from the north.

PLATE VIII.

Sula cyanops (Sundev.). Usong Island, Tub-bataha Reef.



PLATE I.

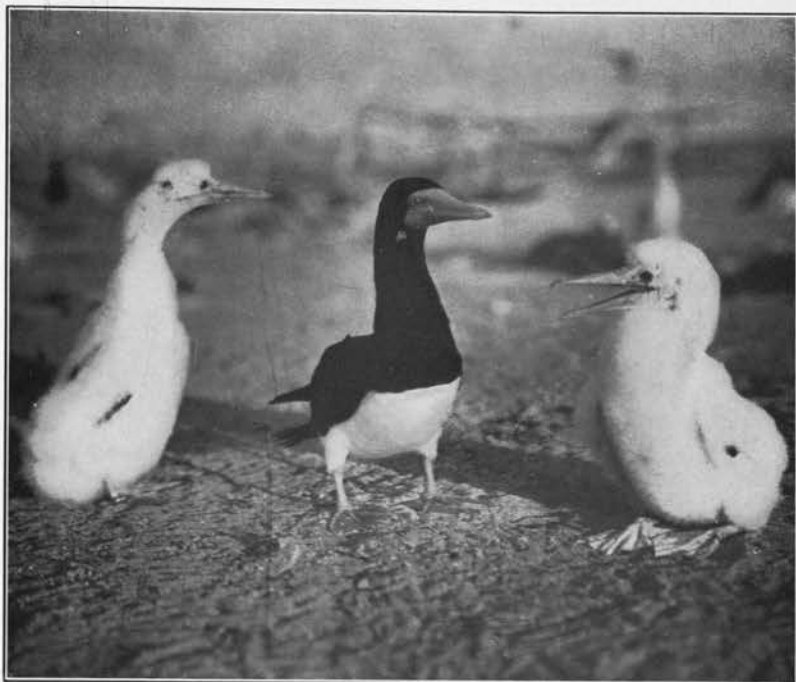


FIG. 1.



FIG. 2.



FIG. 1.



FIG. 2.



FIG. 1.



FIG. 2.



FIG. 1.



FIG. 2.



FIG. 1.



FIG. 2.



FIG. 1.

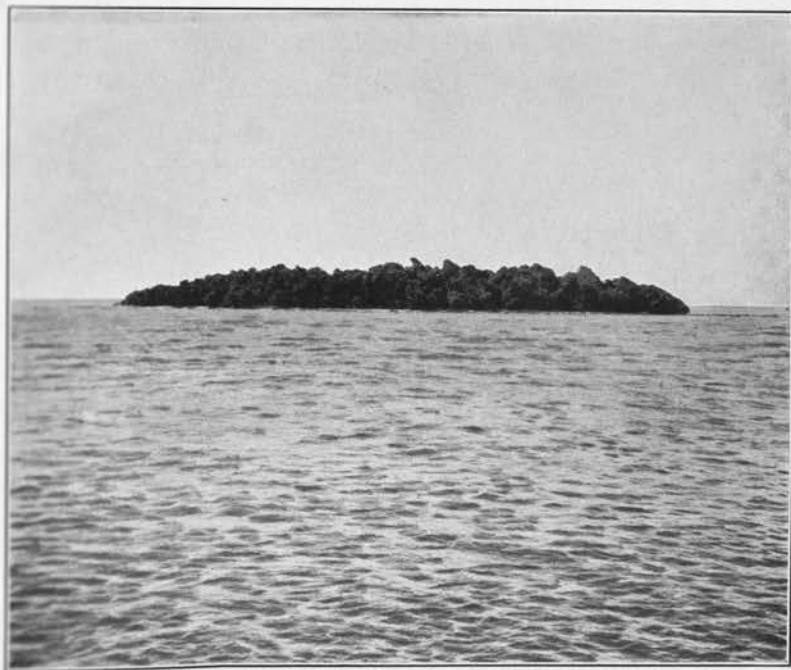


FIG. 2.

PLATE VII.

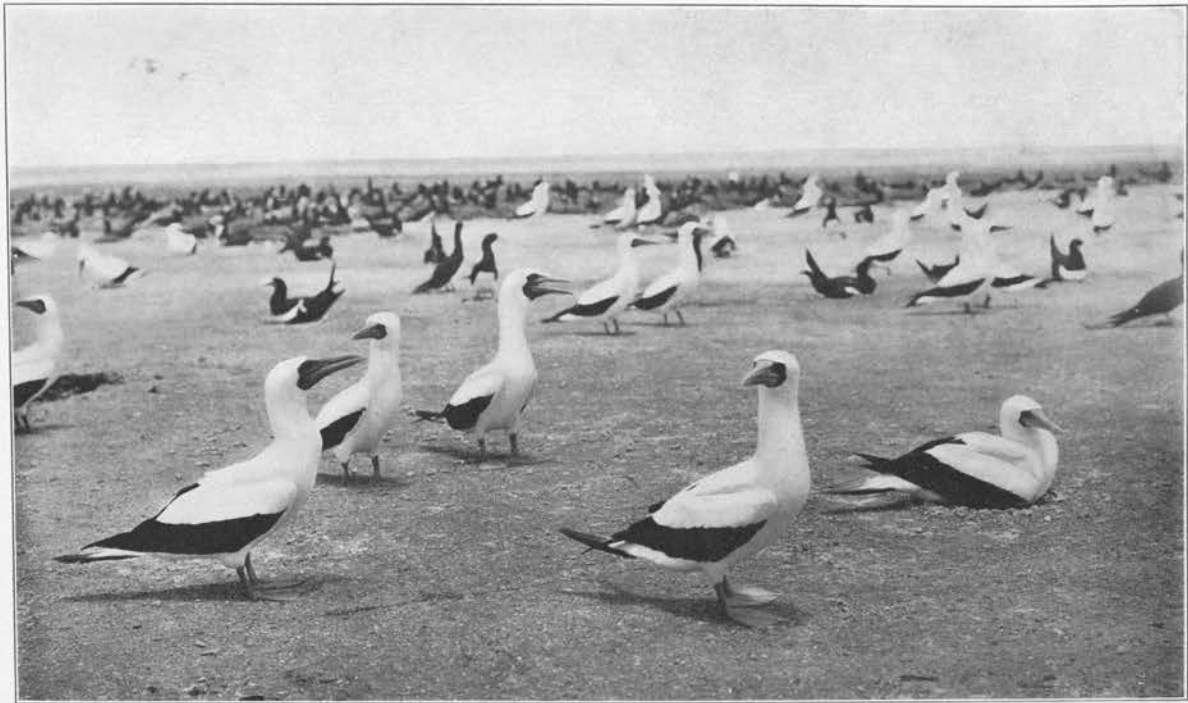


PLATE VIII.

HYBRIDISM AMONG BOOBIES.

By DEAN C. WORCESTER.

On the morning of June 29, 1911, while observing the boobies on Usong Island at the northern end of Tub-bataha Reef, I saw and shot an extraordinarily colored individual which had every appearance of being a hybrid. This led me to walk the length of the island several times, carefully searching among the thousands of nesting birds for other similar individuals. I found two, and I am satisfied that there were no more.

What interested me still more was to find a female *Sula cyanops* mated with a male *Sula leucogastra*. The latter was in full breeding plumage and his sex was conclusively proved by the color of his legs and feet and of the bare skin of his head.

The strangely matched pair had a nest to which they promptly returned whenever I drove them away. It contained no eggs, but this was a lack which was evidently soon to be remedied! There was no possible doubt that the birds were mated, and it seems not improbable that the three hybrid individuals observed, all of which proved to be fully adult, may have been their offspring.

ILLUSTRATION.

PLATE I. Portion of colony of nesting boobies on Usong Island showing a female *Sula cyanops* (Sundev.) mated with a male *Sula leucogastra* (Boddart.)
(Photograph by Worcester.)



PLATE I.

HYBRIDISM AMONG BOOBIES.

By DEAN C. WORCESTER.

On the morning of June 29, 1911, while observing the boobies on Long Island at the northern end of Tub-bataha Reef, I saw and shot an extraordinarily colored individual which had every appearance of being a hybrid. This led me to walk the length of the island several times, carefully searching among the thousands of nesting birds for other similar individuals. I found two, and I am satisfied that there were no more.

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(Photograph by Worcester.)



PLATE I.

RECORD OF A PUFFINUS NEW TO PHILIPPINE WATERS AND
DESCRIPTION OF A NEW SPECIES OF MICRANOUS.

By RICHARD C. MCGREGOR.

(From the Section of Collection of Natural History Specimens, Biological Laboratory, Bureau of Science, Manila, P. I.)

Puffinus chlororhynchus Gould.

A female of this species of shearwater was captured aboard the United States Army transport *Crook*, July 30, 1910, off the Zambales coast, Luzon. Length, 230 millimeters; extent of wings, 960. Legs and feet pale bluish white, brown along the outer side; bill dark horn-brown; iris brown. No. 13172, Bureau of Science collection. Collected by Dean C. Worcester. Dr. Charles W. Richmond of the United States National Museum has examined this specimen and agrees with my identification of it.

Micranous worcesteri sp. nov.

Type.—No. 7300, adult male, Bureau of Science collection. Collected on Cavilli Island, Sulu Sea, Philippine Islands, September 24, 1910, by Dean C. Worcester, R. C. McGregor, and A. Celestino. Bill black; tarsus and toes dark, reddish brown; nails black. Length, 355 millimeters; wing, 222; tail, 120; exposed culmen, 43; bill from nostril, 31; tarsus, 21; middle toe with claw, 38.

Specific characters.—This species is undoubtedly closely related to *M. leucocapillus* Gould, but it differs in having a darker, grayer tail, and somewhat longer toes.

Immature.—Large nestlings with rectrices not extending beyond the toes resemble the adult in plumage, but the forehead, crown, and nape are nearly pure white instead of ashy gray.

Nest and egg.—The nest of *Micranous worcesteri* consists of a mass of leaves with little or no depression for the egg, and is situated on the branch of a tree. A nest is about 10 centimeters in diameter. The only egg collected by us contained a dead chick and measures 46 by 27

millimeters. Color dull white with a few, large spots of burnt umber about the larger end.

Remarks.—As described by Worcester this species is abundant on Cavalli Island during its breeding season. Several of our specimens have been examined by Dr. Charles W. Richmond to whom I am indebted for notes on the various species of the genus. The species is named for Mr. Dean C. Worcester through whose interest and efforts it was discovered.

THE SKELETON IN THE FLYING LEMURS, GALEOPTERIDÆ.

By R. W. SHUFFELDT.

(Washington, D. C.)

(Concluded.)

THE SHOULDER GIRDLE.

Comparative anatomists have observed great differences in the morphology of the shoulder girdle among the various representatives of the Insectivora, not finding this structure alike in any two families of the order. *Cynocephalus* has the two bones composing it, the clavicle and the scapula, remarkably well developed and in full proportions for the size of the animal.

Making the usual articulations with the sternum and the scapula, we find the clavicle to be a large, strong bone. Its extremities are enlarged to support the articulatory facets. The shaft is stout with its continuity of nearly uniform caliber, and presents two curvatures. About two-thirds of its mesial length offers the least apparent curvature, being slightly and uniformly bent so as to present the concavity to the front; the remaining third of the bone makes a very decided curve to arrive at its scapular articulation. This part of its shaft is somewhat antero-posteriorly flattened, or rather compressed, being nearly flat behind and concave in both directions anteriorly. In the normally articulated skeleton, this curvature allows the clavicle to pass over the prominent coracoid process of the scapula, and brings its outer extremity in articulation with the external process of the two apophyses which finish off the upper end of the acromion process of the scapula. In one of the specimens from the Bureau of Science (2) the clavicle has a length of 3.6 centimeters while it is only 3.4 centimeters in the Steere specimen, and 3.5 centimeters in the remaining individual (3). Therefore it averages 3.5 centimeters in length, and is about as long as one of the thirteenth pair of true, or vertebral, ribs of the skeleton to which it belongs.

It is somewhat remarkable that the scapula in some specimens of *Cynocephalus* does not fully ossify; this lack of ossification occurs in the so-called "blade" of the bone (Plate 11, figure 5 (1): see explanation

of plates), while in others it is very complete and rather thick (2, 3). Again, the scapula in different individuals is prone to vary in some of its characters, but to no greater extent than we find among a series of human scapulæ chosen from adults of the same sex and race. One of the skeletons sent by McGregor (2) has the scapula thoroughly ossified, quite perfect, and presenting all the characters of the bone as they occur in our subject. It is here seen to be a distinctly triangular bone with all its parts highly developed.

Facing upward and inward, the glenoid cavity is rather extensive; the concavity is pear-shaped in outline, and the small end extends upon the base of the coracoid process. From the glenoid cavity to the inferior angle we have the external or axillary border, which here presents a notable departure from mammalian scapulæ generally in being broad and flat for almost its entire length to the lower point of the bone. This flat border is of uniform width to its termination, that is about 4 millimeters, and appears as if it had been formed by bending that much of the blade of the bone abruptly, at a right angle toward the spine, thus creating a deep "infraspinous fossa," but adding nothing to the ventral aspect of the bone. The vertebral or internal border is not as long as the axillary one, and its margin is only very slightly thickened for its entire length. The two borders make an angle of 30° with each other, and the angle thus formed, or the inferior angle of the scapula, is here rounded off rather than acute; the sizable bit of the apex, evidently formed from the usual independent center of ossification, has not yet united with the blade of the bone.¹⁹ The superior border, extending from the inner base of the coracoid process to the angle which in anthropotomy is known as the "superior angle," is here sharp and uniformly concave throughout its length. The superior angle is about a right angle and is rounded as in most mammalian scapulæ. The superior border is only about one-half as long as the axillary one; the vertebral border stands between the two in this respect. A supra-scapular notch hardly exists in the superior border near the coracoid process; indeed, although the greatest concavity of the border here is where it usually occurs, no such break in its continuity is to be distinguished. At its narrowest part the neck of the scapula measures just 1 centimeter, and likewise this is the thickest part of the bone antero-posteriorly, it being about 0.5 centimeter just within the glenoid cavity.

¹⁹ This indicates that the animal was still in a subadult stage when killed. Complete union has taken place in the other two specimens (1 and 3) from which we conclude that they are more advanced in age. In the human species it is not until the sixteenth year that this epiphysis unites with the rest of the scapula at this point.

Smooth and quite level, the subscapular fossa on the venter of the bone exhibits hardly any muscular ridges, the only one of any prominence being a mere indication of such extending from the neck to a mid-point on the vertebral border. Even this may be absent from some specimens.

The coracoid process is represented by a straight, somewhat flattened rod of bone, that may attain a length of nearly 1.5 centimeters. It is extensively attached to a raised base or pedicle at the junction of its inner and middle thirds. This gives rise to a long and a short process, the first assisting in the formation of the articulation for the humerus, and the inner and shorter one for ligamentous attachment. Its longitudinal axis makes an angle with the long axis of the acromion process of about 60° , and an angle of about one-half as many degrees with the plane of the scapular blade. Thus it will be seen that the coracoid is not bifurcated as stated by Flower²⁰ but simply produced both ways from its base, in the same straight line.

Very conspicuously developed, the spine on the dorsum of the scapula commences superiorly or, perhaps, what may be called externally, beyond the glenoid cavity. Here it supports a large acromion process and a metacromion; this is followed by a somewhat flattened pedicle to the scapular neck, and from there on it becomes a thin lamina of bone which gradually slopes away to a point near the middle of the vertebral border. This osseous partition creates the supraspinous and infraspinous fossæ, which are thus thoroughly defined. The latter is about twice the size of the former, and lengthwise is bounded by the aforesaid spine on the one hand and by the raised axillary, described above, on the other. The scapula makes the usual articulations with the humerus and clavicle, and has attached to it, either by origin or insertion, a number of important muscles and ligaments.

THE PELVIS.

Beyond a few unimportant individual variations, the pelves (Plate III, figure 8; Plate IV, figure 14, and Plate V, figure 17) of the three specimens of *Cynocephalus* at hand present the same characters for description. On the other hand this part of the skeleton differs widely in its morphology among the Insectivora as a group, being long in some, short in others, while in such genera as *Sorex*, *Talpa*, and *Chrysochloris* a wide interval separates the pubic bones at the mesial line below, where they usually unite.

When submitted to ordinary maceration in water the two ossa innominata readily part company with the sacrum and with each other. This happened in the case of the Steere specimen here shown in figures 8 and 14. One of the most striking features of the pelvis in *Cynocephalus*

²⁰ Osteology of the Mammalia, 253.

is its unusual length as compared with its width; the former being about 8.7 centimeters and the latter 4.3 centimeters taken opposite the acetabulae.

Its articular surface for the sacrum is upon the inner side of the ilium about 1.7 centimeters from the "crest," and covers an area of a little more than 1 centimeter in length. Dorsally, this area projects as an elongated, sharp crest; otherwise it is entirely confined to the surface of the ilium proper and is faintly divided into two facets, a long posterior or dorsal one, and a shorter oval one, parallel to and in close contact with it.

Flower has stated that in "*Galeopithecus*" the symphysis pubis "is long, as in the Carnivora, and becomes ankylosed."²¹ He is certainly in error in this statement for in all the specimens before me the symphysis pubis is reduced to the merest contact of the bones, the area being very small, and ankylosis never results. (See figure 14.) As he states, the symphysis is long in most Carnivora, and this can be easily verified by examining the pelvis of any of the Felidae.

In the articulated skeleton of *Cynocephalus* the preacetabular portions of the ilia are nearly parallel to each other and lie in a subtransverse plane that makes but a slight angle with the longitudinal axis of the lumbar and sacral vertebrae. The anterior presacral portions of the ilia are directed upward, forward, and outward; the free extremities, which are slightly enlarged and rounded, are about opposite the neural spines of the vertebrae. Thus it will be observed that all the preacetabular portion of the pelvis affords but very slight protection to the contained abdominal viscera; it does afford protection to some extent laterally, and in conjunction with the sacrum and leading caudal vertebrae, to a greater extent dorsally.

It remains to say of the preacetabular part of an ilium that it is sigmoid in form, and for the most part subcylindrical, although exhibiting slight longitudinal flatness dorsally, mesially, and externally. This rod-like part of the ilium gradually expands as it comes to the acetabulum which it assists in forming. The latter is large, being over 1 centimeter in diameter, and presents all the usual mammalian characters. Its cotyloid notch is wide and rather deep; the cotyloid articular ring is well developed; while the bone at the bottom of the cavity is often very thin and always translucent. As usual, it is formed by the three pelvic bones, the ilium, the ischium, and the pubes, the sutures among which have become entirely obliterated within the cotyloid cavity. In fact the only sutural line that persists throughout the life of the individual among any of the three pelvic bones is the one between the rami of the ischium and pubes. It is very distinct in all specimens at hand, and probably is invariably present. (Figure 14.)

²¹ Osteology of the Mammalia, 320.

The postacetabular portion of the pelvis is triangular in outline, the acetabulum occupying one angle, the symphysis pubis another, and the remaining one being at the tuberosity of the ischium, the last two being rounded off. Upon its mesial aspect this part of the bone is uniformly and moderately concave throughout, and entirely unmarked by elevations or depressions. It encloses the very large, oval, obturator foramen, the larger end of which is formed by the ischiopubic rami, where its margin is sharp and clean cut, it being thicker and more rounded for the remainder of the curve of this vacuity.

Externally the surface of the postacetabular part of the pelvis is likewise smooth, with its convexity corresponding to the concavity of the mesial aspect. But one muscular line marks it, and that the usual one, halfway between the obturator foramen and the tuberosity of the ischium, indicating the limitations of the areas where arise certain important muscles of the thigh, or more exactly, of the posterior femoral and adjacent regions.

The external borders bounding this postacetabular portion of the pelvis are rounded, smooth, and continuous for the pectineal line, continuous and slightly thickened for the ramal line, and considerably thickened where formed dorsally by the ischium. The ischium presents two prominent tubercles just without the rami of the cotyloid cavity. They are separated by a shallow valley or notch, and the anterior one has generally been designated as the "spine of the ischium," at least, it has been so-called in the human skeleton, where it affords surface for the origin of the gemellus superior muscle, the gemellus inferior arising from the other tuberosity. These muscles among the lower mammalia are generally known as the gemellus anterior and gemellus posterior, owing to the direction of the longitudinal axis of the body.

THE SKELETON OF THE PECTORAL LIMB.

Both pairs of limbs in *Cynocephalus* are fully and powerfully developed, and they present many points of considerable interest. In writing upon the subject of "the adaptive changes which take place in the segments of the limbs proper in various animals," Flower²² has said:

In what may be considered the first stage of modification each segment of the limb is simply bent upon the one above it. The proximal segments (humerus and femur) remain unchanged in position, the dorsal surface still looking upwards, and the ventral surface downwards, the middle segment is bent downwards, so that its ventral surface faces inwards and its dorsal surface outwards; and the joints between these segments (elbow and knee) form prominent angular projections.

The third segment being bent to a greater or less degree, in the opposite direction to the middle one, retains much of its primitive position, the dorsal surface being directed upwards and the ends of the digits pointing outwards. The relations of the pre-axial and post-axial borders of the limb are unchanged. No

²² Osteology of the Mammalia (1885), 365, 366.

mammal habitually carries its limbs in this position, although the climbing *Galeopithecus* and the Sloths are not far from it. It is, however, very nearly the normal position of some Reptiles, especially the Tortoises, although it is ill adapted for anything but a very slow and clumsy mode of progression.

In *Cynocephalus* the humerus makes the usual articulations with the scapula proximally, and the radius and ulna distally, that are seen among mammals generally. These articulations are in all cases extensive and the joints very perfect anatomically.

The left humerus of the colugo (figure 15) offers the following points for examination, some of which are better seen in the right humerus (figure 16) from the same skeleton, this being due to the different positions in which the bones were photographed. Its characters, including its length and to some extent its size, vary somewhat in various individuals. It is considerably shorter than the ulna or the radius; in man it is the longest bone of the arm.

Viewed in its entirety, upon either its direct inner or outer aspect, the humerus is seen to possess for its continuity the true "sigmoid curve." This curve starts at the head and terminates with the trochlear extremity. Ignoring the prominent ridges its shaft is for the most part subcylindrical in form, the principal departure being at the distal end which is expanded to support the trochlea for the bones of the antibrachium. It is uniformly smooth, and pierced by an oblique, nutrient foramen situated about 2 centimeters distad of the articular part of the head, on the posterior aspect.

The very conspicuously elevated deltoid ridge with its thickened edge extends down the shaft, on its anterior aspect, for about one-third of its length. It commences at the head and slopes away rather abruptly distally. Its nearly straight free margin is almost parallel to the shaft's long axis, its sides being smooth. On the other hand the supinator ridge is low, sharp, and thin, extending from the external condyle almost to a middle point of the shaft, following accurately the lower sigmoidal curvature of the latter, where it is gradually lost.

Among mammals we rarely meet with the humerus possessing a more perfect head than it does in *Cynocephalus*, in which genus it is almost a complete and entirely smooth hemisphere. For the most part its articular surface is distinctly differentiated by its circular limiting line and surrounding shallow groove or neck, the major part of which is seen on posterior view. It reminds one of the humeral head of anthropotomy and surmounts the shaft in a very similar manner (figure 15): Upon either side of it the greater and lesser tuberosities are well developed, the comparatively deep bicipital groove passing the latter down the shaft and the side of the deltoid ridge.

At the distal extremity of the bone, posteriorly, the olecranon fossa is very deep and markedly defined. Its osseous base is thin, and may

be perforated by a minute foramen. The internal and external condyles are large, and pitted for the origin of certain muscles upon either side. Above the internal condyle, anteriorly, there exists a delicate span of bone of no great length. It passes, as a gently curved arch from the condyle, obliquely toward the center of the shaft in a proximal direction forming the supracondyloid foramen (figure 15), which gives passage and protection to the median nerve and brachial artery. Where high division of the brachial occurs, the nerve only, as a rule, passes under it, but may be accompanied by the ulnar-interosseous artery.

The distal points of the trochlea and capitellum lie in the same horizontal plane to which the axis of the shaft is perpendicular. Each constitutes a prominent tuberosity separated distally by a well-marked valley. Both in front and behind they rise to the same transverse line on the shaft, ceasing at the distal boundary of the olecranon fossa posteriorly, and at the rather shallow depression intended for the ulna anteriorly. The smaller tuberosity is flat upon its internal aspect, while the capitellum for the radius is fully double the size with a roundly convex articular surface. The average extreme length of the humerus is about 10.2 centimeters.

Judging from the material at hand it would appear that when the bones of the arm are normally articulated they admit of extreme flexion to a far greater degree than they do of extreme extension, that is, extension to the extent of bringing the long axis of the shaft of the humerus and the ulna into one and the same straight line.

The radius is a very strong and nearly straight bone with enlarged extremities and subcylindrical smooth shaft. It has an average extreme length of 12.2 centimeters, or two centimeters greater than the humerus. (Plate III, figure 9.) At its proximal end, the tuberosity for the insertion of the tendon of the biceps, is represented by a short longitudinal crest, terminating in a groove near which we usually discover the opening of a small nutrient foramen. Above the tuberosity the bone is somewhat constricted to form the neck of the radius and the latter is surmounted by the head of the bone. The head is large, oval in outline, and at its summit exists the rather deep concavity for articulation with the capitellum of the humerus, while its marginal articulatory surface for the ulna is about 2 millimeters deep. The outer lower third, or more, of the shaft is flattened, forming a surface to which the distal fourth of the ulna is firmly attached by ligament. Anteriorly, on its expanded part at this extremity, we note the five conspicuous longitudinal grooves intended for the passage of the extensor tendons as they go to the hand. A sharp, peg-like, styloid process projects forward at the outer side of the bone, but does not extend beyond the border over which the extensor tendons pass. Internal to this process is a deep, elliptical, transverse facet for articulation with the first row of bones of the wrist

a deep notch marks the boundary between the two sigmoid cavities, while on the opposite side the limiting border is continuous and distinctly circular in outline (figure 9). It is unnecessary to add that such an ulna as *Cynocephalus* possesses takes no part in the carpal articulation.

The bones of the arm and forearm vary among the Insectivora to a very marked degree; as, for example, among the hedgehogs, moles, and shrews; and it is said that the ulna in *Macroscelides* and *Petrodromus* is atrophied distally as in the colugo, but whether in these animals it coössifies with the radius at that end may be open to question.

According to Flower:

Among the insectivora, the scaphoid and lunar (in the carpus) coalesce in *Galeopithecus*, *Tupaia*, *Centetes*, *Solenodon*, *Erinaceus*, and *Gymnura*, but in most of the other forms these bones are distinct. A distinct os centrale is found in all except *Galeopithecus*, *Potamogale*, *Chrysochloris*, and *Sorex*.²⁴

A very careful microscopical examination of two wrists, or carpi, in two different specimens of the material at hand, proves beyond all question that this statement, in so far as *Cynocephalus* is concerned, is quite incorrect. All of the eight usual bones of the carpus are to be found in this animal. They are especially well developed in the manus of Steere's specimen, the one from the right pectoral limb having been very carefully examined by me under a high-power lens. There are four bones in the proximal, and an equal number in the distal row.

Commencing at the inner end of the proximal row (ulnar side) we find the pisiform to be represented by a rather large, elongate ossicle that has a facet upon its mesial aspect merging with another distally, the first articulating with the cuneiform, and the latter with the unciform, as in the Felidae and probably other mammals. Cuneiform, one-third larger than pisiform, is of an irregular cuboidal shape, with a small facet for pisiform, and a larger one for unciform and semilunar, the latter being much concaved.

The semilunar is larger than any three of the other carpal bones taken together, and is the only one of the wrist that articulates with the former. This it does with its large semi-ellipsoidal facet on its proximal aspect, intended for the articulation at the distal end of the radius. Its outer extremity also has a rather large, nearly circular, facet with which the scaphoid articulates. Distally, the bone presents a raised, ridgelike, longitudinal articulation for the trapezium; this is separated by a deep groove from a larger, central, likewise longitudinal, raised facet which articulates with trapezoid and os magnum. More internally it offers a small articular surface to the unciform. Thus it will be seen that the semilunar articulates with no fewer than seven bones, viz: radius, cuneiform.

²⁴ Osteology of the Mammalia (1885), 289. This authority's description of the hand in the insectivores will hardly apply with accuracy to the colugo which is unusually large.

unciform, magnum, trapezoid, trapezium, and scaphoid. Scaphoid is a small compressed bone, but is larger than pisiform; it has but a single articular facet covering its entire mesial aspect that articulates with a similar facet on semilunar. It is connected with the trapezium by ligament only.²⁵

Trapezium of the distal row is only exceeded in size by the unciform. It is of an irregular cuboidal shape, with articular facets for the proximal end of pollex metacarpal, trapezoid, and lunar. Above it, attached by ligament only, we find the scaphoid, while mesially it presents a small facet to the proximal end of index metacarpus.

Having very nearly the same form and size, either being parallelepipedal with respect to the former, the trapezoid and os magnum articulate with each other and both with semilunar. Trapezoid also articulates with the metacarpus of index digit, as os magnum does with the same bone of the middle finger.

Unciform is a cube of irregular shape, the last carpal in the distal row on the ulnar side, that articulates with lunar, cuneiform, and the metacarpus of minimus digit, and the inner side of the base of the metacarpus of the fourth phalanx. Its palmar process is but feebly developed.

The manus of *Cynocephalus* is large in proportion to the size of the animal, and exhibits in its skeletal morphology the chief uses to which it is put, that is, being fitted to serve the purposes of climbing rather than of prehension. It is especially long and rather narrow, being armed distally with very efficient and powerfully hooked claws. It is a pentadactyl member with a short pollex and four elongated digits. All the phalanges composing these digits present the usual characters seen among ordinary small mammals. Their shafts are very nearly straight and quite cylindrical, while their distal extremities, or heads, support the usual double trochlea for articulation with the phalanx next beyond them in each instance. The base of each of these long bones is larger than its head and also presents an articular facet, which is oval and concave to receive the head of the phalanx next behind it. The ungual, or distal, joints are entirely different and will be described further on. The metacarpus consists of five bones; distally they articulate with the five proximal phalanges of the digits and at their other ends with the carpus in a manner already pointed out. Pollex metacarpal is very considerably shorter than any of the others; index and minimus metacarpals

²⁵ In describing this bone as the scaphoid, the fact is known to me that among rodents there are many wherein the scaphoid and lunar unite to form a single bone; and further that a special ossicle, which has been described as occurring on the radial side of the wrist, is of very considerable size in *Castor*. It has also been said that in the beaver the scaphoid and lunar fuse to form one bone. Notwithstanding these statements it is contended here that the scaphoid is present in *Cynocephalus*, though embryology may disprove it, and two centers of ossification may be shown to exist in the bone here described as semilunar.

come next in length and nearly equal each other in this respect. Medius and annulus metacarpals are also of equal length and larger than any of the other bones of this part of the hand. Pollex metacarpal is the stoutest of them all and is about 1.6 centimeters long; minimus is also stout and has a length of about 2.8 centimeters, while that of index is 5 millimeters shorter. The shafts of the middle and ring, or the medius and annulus, metacarpals are rather more slender, and each is nearly 3 centimeters long. These metacarpal bones are slightly curved palmar and like the phalanges, nearly parallel and very close to each other when the member is at rest. Pollex has one short (1.5 centimeters), stout phalangeal joint and an ungual joint; all the other digits have three each including the ungual joints. Index is the shortest finger, minimus next, with medius and annulus of about equal length. Not including the terminal joint, annulus has a length of about 4 centimeters.

The ungual joints are all very much of the same form and size; the largest being on pollex, index, and the next two digits, the smallest on the little finger. Any one of them is very deep from dorsal to palmar border, the latter being slightly concave, and the former powerfully convex and a little jagged distally. From side to side one of these thoroughly ossified joints is uniformly compressed to extreme thinness, while its proximal border is somewhat thickened for the articular facet and for tendinal insertions. At the postero-dorsal angle there is a very small, concave, circular process for the insertion of the extensor tendon; palmar to this is a large concave facet divided by a median longitudinal ridge. This concavity is twice as deep as it is wide, and its surrounding border is raised above the general surface. Palmar to this again, at the postero-palmar angle, there is another very small process for the insertion of the flexor tendon, while above this, beneath the lower border of the mid-articular facet, are two minute foramina, side by side in the transverse line. They lead into the bone and appear to be nutrient foramina.

The horny theca, sitting as a claw over one of these ungual joints, is also powerfully compressed from side to side, and in form, with its very sharp apex, resembles upon lateral view the upper bill of one of the smaller typical falcons.

On the palmar aspect, beneath the articular joints of the metacarpals and phalangeal bones, we observe in the case of each digit a pair of sesamoids. These have the form of small compressed ellipsoids, the largest ones being in the proximal tier of bones, whereas in the case of the smaller pairs beyond, they are placed side by side in the transverse line.

Distally, the sesamoids are very minute and may be absent in the index digit, between its first and second phalanx. They do not occur, apparently, beneath the ungual joints at all. These sesamoids occur in the hands and feet of other mammals, as certain carnivora, and even in the tendons running to the toes on the plantar aspect of the foot in man.

THE SKELETON OF THE PELVIC LIMB.

Proportionately, the pelvic limb of *Cynocephalus* is not as powerfully developed as is the pectoral limb, though there seem to be exceptions to this general rule. In Steere's specimen, for example, the long bones of the posterior limbs are fully as well developed as are the corresponding ones in the anterior extremities. However, pes always seems to be weaker and somewhat smaller than manus, and this is also evidenced in the skeleton of these parts.

In the matter of proportions there are very marked differences in the pelvic limbs of the three skeletons at hand. These differences may be due to the fact that they came from different species, or if from the same species, it may be due to differences in age or even sex. In any event the Steere specimen was a much bigger animal than either of the McGregor specimens, and one of the latter (3) is larger than the other (2), though the characters throughout agree.

Two of the femora, selected as examples, show how marked these differences are; for instance, the right femur of the Steere skeleton has an extreme length of 12.3 centimeters, as compared with the extreme length of the femur in the smaller of the two individuals from the Bureau of Science, which is only 11.1 centimeters. Then in the matter of actual size the two bones are also in proportion to this difference in length, the shaft of the femur in the first case being fully one-third larger than in the second case.

The description of the pelvic limb here given is from the right side of the skeleton in Steere's specimen, with occasional reference to the other two individuals.

The femur (Plate II, figure 6), possesses a stout, straight, cylindrical shaft, which is so smooth that even *linea aspera* is scarcely indicated upon it. The proximal extremity of the bone presents an elegant, smooth, hemispherical head, in fact so globular is it that it approaches the sphere. This head is marked by no pit for the *ligamentum teres*; its boundary is sharply defined in front; less so behind, where the articular surface encroaches slightly upon the summit of the shaft of the bone. The axis of the head and neck makes an obtuse angle with the axis of the shaft, thus bringing the head above the latter's summit. Conspicuous and rough, the great trochanter curves slightly to the front, thus making the neck of the bone very distinct behind it and the *caput femoris*. Minute nutrient foramina may occur in this locality. On the postero-external aspect of the great trochanter there is a well-marked pit, the so-called trochanteric fossa, within which certain muscles are inserted.

Situated internally and at the same time posteriorly, and about 1 centimeter below the head, there arises the lesser trochanter, sometimes called the tibial trochanter. It is bluntly triangular in form, and arises from a substantial base. On the opposite side of the shaft, that is, on its

external border, and rather lower, there is still another and smaller process, which is the third trochanter. Between these two projections on the posterior aspect of the bone, the shaft is very smooth and particularly flat. No spiral line joins the greater and lesser trochanters on the anterior surface of the bone, while posteriorly, the trochanteric line is very feebly pronounced in the corresponding locality. Both these lines, or intertrochanteric ridges, are very noticeable in the femora of many other mammals, man included.

At the distal end of the shaft the two condyles are strong and thick. They are almost exactly of the same size and neither one is lower on the shaft than the other, as is sometimes the case among mammals where the inner condyle is the lower of the two.

The smooth, convex, articular surfaces seen posteriorly on these condyles are practically of exactly the same size, and they terminate in the same transverse planes, both above and below. Between them is a deep, sharply defined, intercondyloid notch, that terminates abruptly at the lowest plane of the bone and superiorly in a similar manner on a flat surface named in anthropotomy the popliteal space. Again, either the internal or external condyle exhibits upon its outer surface a distinct pit, or depression, wherein certain muscles arise or are inserted. One is about as well marked as the other, as are the tuberosities that occur, one in each case, above them. The one on the outer condyle is the outer tuberosity, and the other the inner tuberosity. Anteriorly, the intercondyloid space is of a nearly quadrilateral outline; it is smooth, slightly narrower above than below, gently concave from side to side, and roundly convex in the longitudinal direction with respect to the axis of the shaft. This surface is shown in figure 6.

The patella is poorly developed in *Cynocephalus*. It may, or may not, be completely perforated in bone, and there is reason to believe that in young specimens it will always be found in cartilage or at the best in very elementary osseous tissue. When in bone it is not large, though it extends from a point opposite the center of one condyle to a point opposite the center of the other, being parallelogramatic in outline, with the long sides transverse. Anteriorly, the patella is convex from above, downward, and correspondingly concave posteriorly. The tendon in which this sesamoid is embedded, the quadriceps extensor, is very tough and strong and is inserted on the free anterior border of the head of the tibia.

The tibia is the longest bone in the skeleton of this animal; it is, however, by no means the stoutest, being exceeded in this respect by both the humerus and the femur. Proximally the tibia has a shaft the caliber of which about equals that of the femoral shaft at the junction of its upper and middle thirds, but as we pass to the distal end this caliber gradually diminishes until just before arriving at the lower end of the

bone. The shaft, likewise, exhibits a curvature from one extremity to the other, the greatest amount being at its middle; the entire convexity is on the outer side. The shaft of the tibia in most mammals is triangular in section, but in *Cynocephalus* it is quite quadrilateral, especially where its caliber is at its minimum. A shallow longitudinal groove marks its outer aspect, being best seen along the middle third; otherwise the bone, or rather its continuity, is devoid of any particular characters.

The proximal end, or what is known as the head of the bone, is expanded and nearly as big as the distal end of the femur. This expansion gives rise to two lateral eminences, the tuberosities of the tibia. They support superiorly the two smooth concavities with which the condyles of the femur articulate in life. In extent they are of about equal size, and between them toward the back of the bone is a low, pointed process, the spinous process of the tibia. A slight notch occurs in the posterior border bounding the tibial head which has received the name of the popliteal notch, and to it the posterior crucial ligament is attached. On the outer side of the head there occurs a flat, subcircular, articular facet intended for the head of the fibula. It is of no great size. Posteriorly, the boundary of the head somewhat overhangs or extends beyond the shaft, which is here broad, flat, and smooth.

The enlarged distal end of the tibia is not more than one-half the bulk of the proximal extremity, and it has a form to fulfill a variety of purposes. Chief among these are its articulation with one of the bones of the metacarpus, its articulation with the fibula, for the passage of tendons of certain muscles, and for ligamentous attachment. At its inner side it is prolonged distally into a prominent process which is the internal malleolus. Just above this there is a deep, oblique groove, its lower opening being in front. In life this groove gives passage to the tendons of the flexor longus digitorum and the tibialis posticus muscles. There is a small, rough, inconspicuous facet on the outer side of this distal end of the bone with which the lower end of the fibula articulates. The extreme inferior surface of this extremity is given over entirely to a broad, spindle-shaped, articulate concavity which in life articulates with the astragalus; internally this is carried slightly up the shaft, or at least upon the back of this end of the bone. In front this extremity is convex from side to side and very smooth; over it in life glide the extensor tendons.

The fibula is very nearly as long as the tibia, being exceeded only by the internal malleolus of the latter. On the whole it is the most slender long-bone in the skeleton and, for its length, the straightest. Some specimens have the proximal moiety reduced to extreme slenderness while the head of the bone at that end, which makes a feeble articulation with the tibia, is always reduced to a mere semiellipsoidal nib, only a few millimeters long, flattened on its inner articular aspect, and convex

on its outer. The shaft is smooth, compressed from within, outward, and very gradually increases in caliber toward its malleolar extremity. In one specimen (3) this bone is deeply and longitudinally grooved for the entire upper one-third of its tibial aspect.

Bulbous in shape, its distal end forms the external malleolus, being obliquely truncate from above, downward, and outward; the inner surface is given over to the facets for articulation with the tibia and the astragalus of the foot. Above this is a distinct little process for ligamentous attachment. There is another, but larger, tubercle on its outer aspect. Ligaments of the ankle are also attached at a few other points; in fact, the most important function of this bone in *Cynocephalus* is to assist in completing this very essential joint.

Pes contains the same number of metatarsals as manus contains metacarpals, and the toes the same number of phalanges as we find in the hand; that is, three joints in all the toes with but two in hallux.

The study of the foot of *Cynocephalus* is wonderfully interesting. Owing to the unusual way the member has been used and ontogenetically evolved, it has the appearance, on first sight, of having been dislocated. The articulatory part of the astragalus which articulates with the tibia, and to some extent the bone itself, has rotated inward and to a degree forward, so that the longitudinal axis of this long and narrow foot makes a varying angle with the continuity of the shafts of the bones of the leg. This angle in the vertical plane may range all the way from 120° through a right angle to an acute one of 70° , according to the manner in which the animal holds its foot. The member possesses also a certain amount of motion either backward and forward, when the limb is held away from the body, or inward and outward, when it is brought near the latter and the effort is made to move the foot in those directions.

Flower²⁶ states, and it is true, that "The bones of the tarsus of mammals present fewer diversities of number and arrangement than those of the carpus." *Cynocephalus* offers no exception to this rule.

There are seven bones in the tarsus of the colugo, namely the astragalus, the os calcis or calcaneum, the scaphoid or navicular, the three cuneiforms (internal, middle, and external), and the cuboid. This enumeration does not take into consideration the presence of several important sesamoids which will be noticed farther on.

The astragalus of all the tarsal bones is next in size to the os calcis, the latter being the largest bone of the foot. In man this bone receives

²⁶ Osteology of the Mammalia, 340. Many works have been examined in this connection, and the literature of the subject is very extensive, but it would appear that no author as yet has produced sufficient evidence to warrant any radical change in the nomenclature of the tarsal bones, or to set aside their homologies as they have long been given in standard treatises on anatomy.

the weight of the body in standing and walking, transmitted to it from the tibia, and to a very slight degree the fibula. Quadrupeds have this weight variously divided, while in *Cynocephalus* it appears that this tibio-tarsal joint sees its chief use as an enarthrodial articulation. Usually the very irregularly-shaped astragalus is described as having a head, a neck, and a body, and such divisions are easily made out. When duly articulated, the head projects to the front in line with the scaphoid, the cuneiform bones, and the first and second toes. Anteriorly the head has a large, smooth, convex facet which articulates with a concavity in the scaphoid and a surface on the antero-superior aspect of the os calcis.²⁷ The latter encroaches upon the surface of the neck beneath. The neck is somewhat compressed from above downward (here really from side to side), and is wider in the opposite direction. The entire upper part of the body is occupied by an elegant, smooth, convex facet for articulation with the two bones of the leg. This articular surface is carried over upon the sides of the astragalus, and here the malleoli of the aforesaid bones articulate, as is the case with nearly all mammals. Fibula gets the smaller share, a little less than one-half of this articulation. Posteriorly and beneath we note a well-marked groove, which in life gives passage to the tendon of the flexor longus hallucis muscle. On the sides there are pits for the attachment of ligaments. At the center of the bone, on the side next to the os calcis in articulation, there is an irregular concavity; this is on the neck, while posterior to it on the body there is an elliptical facet for a similar one on the calcaneum. No muscle either arises from, or is inserted upon, the astragalus, and as pointed out above the astragalus articulates with four bones: tibia, fibula, calcaneum, and scaphoid.

The os calcis or calcaneum, is longer, narrower, and larger than the astragalus; the latter projects just a trifle more to the front, while the former exceeds it in length behind. Altogether the bone is very irregular in form and has the tendons of a number of muscles and ligaments attached to it, or arising from it. Os calcis is the tarsal that forms the skeletal part of the heel and here we find this posterior extension to be a distinct semi-ellipsoidal projection, subvertically placed upon the body of the bone. This is generally called its tuberosity, and upon it is inserted the tendo Achillis. Beyond it, the body of the bone is somewhat constricted and compressed from side to side. Mesially, it throws out a conspicuous triangular process, the upper side of which articulates with the under side of the neck of the astragalus. A similar, rather smaller,

²⁷ In assigning directions, and the directions in which surfaces look or face, for the sake of convenience, it is assumed that the animal stands on the ground as do ordinary quadrupeds, otherwise it would be very difficult to appreciate the relations of the tarsus to the rest of the skeleton, and the most unusual position in which the foot is held with respect to the surface upon which the animal is traveling.

apophysis, occurs on the outer aspect of the bone just posterior to the cuboidal articulation; this is intended for muscular insertion.

Anteriorly, the face of the os calcis is entirely given over to a concavo-convex articular facet for the cuboid, which presents a peculiarity, in that it is conically hollowed on the planter border; into this fits a pea-like articular process on the cuboid. On the under, or planter, side of this the two bones are firmly lashed together by a broad tough ligament. There would appear to be some special cause for the development of a joint such as this, but the cause is not apparent. Internal to the cuboid articulation there is a small facet for the scaphoid. When the two tarsal bones thus far described are articulated, and we view them from what is really the outer side, we note that the plantar aspect of the neck of the astragalus is oblique and arches over a similar groove on the calcaneum, the two forming a foraminal passage through which we can look. In the recent state this is filled up by the calcaneo-astragaloid interosseous ligament, and is present in nearly all ordinary mammals.

The cuboid in *Cynocephalus* is really more or less cuboidal in form; its posterior articular face has already been described. It is also articular in front where its slightly concave surface is divided by a ridge into two, for the fourth and fifth metatarsals. There is a strong oblique groove on its plantar surface, and this lodges the tendon of the peroneus longus muscle. On its mesial aspect the cuboid makes an extensive articulation with the scaphoid, and also the external cuneiform. Thus it articulates with four bones: calcaneum, scaphoid, and the fourth and fifth metatarsals.

Os naviculare, or scaphoid, is rather larger than the cuboid and its posterior articulation is somewhat remarkable, for it not only articulates with the head of the astragalus, but on its plantar aspect on the margin of this articulation, it sends back a distinct process the side of which articulates with the os calcis, and upon which the plantar surface of a part of the head of the astragalus rests. This process has a notch on its outer side. Anteriorly, it has facets to articulate with the three cuneiform bones. These are all more or less cuboidal in form, differing a little in the matter of size, and each articulates anteriorly with the base of a metatarsal. The internal cuneiform is the largest and joins the hallux metatarsal; it extends farthest to the front; the middle one is the smallest, and the external one is between the two in point of size.

The three middle metatarsals very closely resemble the corresponding bones in the hand, while in the foot a peculiarity is seen in hallux metatarsal in that it has a conspicuous, rounded process erected on the dorsal aspect of its extreme distal end. The articular surface in front is carried upon this, affording the joint next beyond an unusual amount of backward play in the vertical plane.

The metatarsal of the little toe is almost as stout as, and considerably longer than, hallux metatarsal, and as in many other mammals it develops a process proximad that projects from the side of the foot. This is the tuberosity of the fifth metatarsal; in man and probably in many other mammals the peroneus brevis muscle is attached to it.

The distal phalanges as well as the greatly compressed ungual joints, closely resemble those of manus and consequently require no special description.

At the side of the foot, a short distance back of the hallux metatarsal and apparently encased in the lateral ligaments in that locality, there is a large, flat, quadrilateral sesamoid. It is on the tibial side of the tarsus and rests, flatwise, on the scaphoid and internal cuneiform bones. Baur took this to be the rudimentary tarsale tibiale in which he was doubtless mistaken, as it is sesamoidal in all its characters.²⁸

It would appear that no special name has as yet been bestowed upon this bone, so it might conveniently be known as the tarsal sesamoid.

There are other sesamoids in the sole of this foot, and they agree in all particulars with the corresponding ones in the hand. We see them, proximad, just within the tarsophalangeal articulations, a pair back of each joint, and very much smaller pairs in the row of joints beyond. Occasionally specimens are found having a few very small sesamoids in the sole of pes, and in the partly cleaned skeleton the palmar surface of the process projecting backward from the scaphoid may easily be mistaken for one, as it is exposed there and has the same elliptical form.

No tendon of any of the muscles in *Cynocephalus* has been found to ossify, nor have there been, beyond the rings of the trachea, any other ossifications met with in this animal.

So much then for the osteology of *Cynocephalus*, the caguan, the aberrant insectivore of certain islands of the Indian Archipelago, which we know is certainly no lemur.

THE HYOID ARCHES AND THE LARYNX.

As stated above the specimens here described lacked the hyoid arches and the trachea. This I communicated to Mr. McGregor by letter and in due time received the following reply from him.

I have, unanswered, your letters of October last and of January of this year [1909.] I am glad to know that you have a paper on *Galeopithecus* roughed out and I will hope to be on hand to see it copied and to read the proof for it. I regret that the specimens sent you were incomplete. They were prepared in the field by my assistant at a time when we had a great press of other work and you know what that is in a hot climate. I am fortunate in having on hand a pickled specimen of the lemur from Basilan, doubtless the same species

²⁸ *Amer. Nat.* (1885), 19, 349. This bone has also been discovered to exist in *Hyrax*, the duckbill, certain Rodentia, and in some of the Edentates.

as the Bohol specimen, and I will forward the entire head and neck of this in hope that you may be able to dig out the hyoid from it. It has been long in formalin so that the bones may have softened a bit or perhaps hopelessly so, at any rate I think it worth while to forward in case it will complete your description.

If you have already mailed your manuscript you can write out the hyoid matter and send to me with indication where to insert, etc., and I will see that it is properly placed in your manuscript.

Toward the latter part of April, 1909, I received by mail the above mentioned head and found it to be a specimen of the kind described by Mr. McGregor and in a very satisfactory condition for dissection. I have carefully dissected the hyoidean apparatus, the larynx, and about an inch of the trachea (all that came with it) of this specimen.

I have compared all the parts with the corresponding ones of a domestic cat as figured by Mivart, and with several other species of the Carnivora, bats, etc. Upon the whole it agrees pretty well with the first-named animal, except in the matter of the tympanohyal, and it was Flower²⁰ who said:

The hyoid [in the Insectivora] is formed generally like that of the Carnivora, with three complete extracranial ossifications in the anterior arch, a transversely extended basihyal, and tolerably long, stout, flattened thyrohyals, sometimes ankylosed with the basihyal.

The tympanohyal in *Cynocephalus*, if it exists at all, is very small and coössifies with certain bones at the base of the skull between the periotic and tympanic elements in the neighborhood of the stylomastoid foramen.

Neither Dobson nor Flower, I believe, ever described the hyoid or the ossifications of *Cynocephalus*, and in fact up to the present time I have not met with any observations of any kind upon this part of the skeleton of the flying lemur.

The specimen at hand is from a fully adult animal and probably ossification in the parts has gone as far as it ever goes in this species, though in individuals attaining an unusual age it may be carried somewhat further.

The anterior cornu has a length of 1.5 centimeters, and the posterior cornu has a length of 6 millimeters, while the average height of the laryngeal box is 7 millimeters, and its width about the same, the former including the crinoid cartilage.

So much of the windpipe as remained with this specimen is composed of vertically narrow, closely adjusted rings. These rings are not large; they are transversely elliptical, performed in elementary bone, and while thinner posteriorly they appear to unite in bone in the medio-vertical line; the first few superior rings certainly do. All the parts usually found in the larynx among the higher vertebrates are present, but it is only in the case of the anterior thyroid alæ that firm ossification is

²⁰ Osteology of the Mammalia, 176.

observed; all the other elements remain in cartilage and these, apart from the ericoid, fuse more or less together.

The hyoidean apparatus rests directly upon the top of the larynx and it is only the limbs of the anterior cornua, including the epihyals and stylohyals, that stand out independently; these project posteriorly. Each thyrohyal is broadly paddle-shaped, the blade being in front and directly articulating on either side with basihyal. They only connect with the superior cornu of the thyroid by means of cartilaginous extensions. Parallelogramic in outline, the basihyal is nearly flat, being but very slightly concave from side to side posteriorly, and correspondingly convex in the same direction in front. The stylohyals are entirely in cartilage and rudimentary, while both the epihyals and ceratohyals are in bone, each being represented by extremely delicate little rods, making feeble articulations with each other upon either side, and with the basihyal anteriorly.

It will be of interest to mention, incidently, that *Cynocephalus* has a very large thick tongue, finely serrated on the thin edge of its semi-circular, anterior margin. The roof of the mouth is peculiarly corrugated in curious, transverse, zigzag lines, and these being raised leave strong similar impressions on the superior surface of the tongue. This last may be of a post-mortem nature and may not exist during life.

NOTES ON THE OSTEOLOGICAL MATERIAL REPRESENTING THE GALEOPTERIDÆ IN THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUM.

After the typewritten copy of this memoir had been forwarded to me by Mr. McGregor for revision and had received my careful reading, it occurred to me that the value of the memoir would be greatly enhanced if certain parts of it were read by such an eminent writer on mammalogy as Mr. Gerrit S. Miller, jr., curator of the division of mammals in the United States National Museum. Mr. Miller at the time was in Europe, and did not return to Washington until the early part of September, 1910. On the first of the following month I took the material I had described, together with the typewritten manuscript to Mr. Miller at the Museum, and after taking up some of the points in the latter, he advised me to make a thorough comparison of the skeletons and skulls of my own collection with those of the far more extensive collection of the Galeopteridæ belonging to the United States National Museum, together with a series of skulls of flying lemurs loaned him by the Bureau of Science. Mr. Miller informed me that all the species of these animals belonging to the Malayan fauna were now contained in the genus *Galeopterus*, and that the Philippine species *volans* was of the genus *Cynocephalus*.

There are a number of Malayan species and perhaps subspecies, but

the skins and osteological material of the Philippine forms were as yet not sufficiently extensive in the National Museum collections to differentiate them. In addition to the above-mentioned material, Mr. Miller placed at my disposal a particularly fine and perfect mounted skeleton of an unidentified Malayan form of flying lemur belonging to the National Museum. This specimen was photographed for me by Professor T. W. Smillie, chief of the photographic division of the National Museum, and the reproduction of this photograph illustrates the present memoir as a frontispiece. It is particularly valuable as showing the skeleton in one of these animals with all the bones, even including the hyoid and trachea, normally articulated. There is listed in the following tables all of the osteological material (October 1, 1910) representing the flying lemurs in the collection of the United States National Museum, which I have compared and studied. The scientific name given is the name on the label attached to the specimen. Such information likewise applies to the locality, sex, and name of collector given. In some instances the condition of the specimen is added.

Skulls of Cynocephalus from the Philippine Islands, United States National Museum collection.

U. S. Nat. Mus. number.	Original number.	Name.	Locality.	Sex, age, etc.	Collector.
144663	6145	<i>Cynocephalus volans</i> .	Catagan, Mindanao.	Adult ♂; broken, incomplete.	E. A. Mearns.
144662	6046	do	Basilan Island, Isabela.	Adult ♂	Do.
144660	6036	do	do	do	Do.
144659	6034	do	do	do	Do.
123422		Colugo.	Pantar, Mindanao.	Not given; adult, perfect.	Not given.
144655	6027	<i>Cynocephalus volans</i> .	Basilan Island, Isabela.	Adult ♀	E. A. Mearns.
144657	6030	do	do	Broken up; adult ♂.	E. A. Mearns, 1906.
144656	6028	do	do	Adult ♀; perfect	E. A. Mearns.
144658	6033	do	do	Adult ♀	Do.
144661	6038	do	do	Juvenile ♀	Do.

Skulls of Cynocephalus from the Philippine Islands, Bureau of Science collection.

Original number.	Name.	Locality.	Sex, age, etc.	Collector.
105	Not given	P. B. S.	Adult ♂	R. C. McGregor.
111	do	Bohol	Not given	Do.
108	do	do	Adult ♀	Do.
104	do	do	Adult ♂	Do.
106	do	do	do	Do.

Two skeletons of Malayan species. United States National Museum.

U. S. Nat. Mus. number.	Name.	Locality.	Sex, etc.	Collector.
49640	<i>Galeopterus</i> sp.?	Pulo, Bintang	Adult ♀	(?)
154900	do	Mount Sahak, Tandak	Juvenile, complete	O. Bryant, 1909. Java Expn.

Skulls of Malayan species, United States National Museum.

U. S. Nat. Mus. number.	Original number.	Name.	Locality.	Sex, age, etc.	Collector.
122841	2454	<i>Galeopithecus</i>	Malacca Strait, G. Karimon Is- land.	♀ adult	W. L. Abbott.
144373	5089	do	Rhio Arch., Pulo Jombol.	do	Do.
144372	5088	do	do	♂ adult; full of shot holes.	Do.
144377	5095	do	do	♀ adult	Do.
123035	2616	<i>Galeopithecus</i> sp.?	E. Sumatra, Pulo Bakong.	♂ subadult	Do.
123086	2700	do	E. Sumatra, Pulo Penuba.	♀ adult; broken	W. L. Abbott, 1903.
123088	2717	do	do	do	Do.
123087	2701	do	do	♀ adult; perfect	Do.
123069	2676	do	E. Sumatra, Pulo Sebang.	♂ adult	Do.
112427	1000	<i>Galeopithecus aoris</i>	S. China Sea, Pulo Aor.	do	W. L. Abbott, 1901.
104600	463	<i>G. gracilis</i>	Natuna Islands, Sirhasen.	do	Do.
104497	154	<i>G. pumilus</i>	Butang Islands, Pulo Adang.	♂ juvenile; perfect	W. L. Abbott, 1899.
121748	2235	<i>G. saturatus</i>	Batu Islands, Tana Bala.	♂ adult; perfect	W. L. Abbott, 1903.
121749	2277	do	do	♂ adult; badly shot up.	Do.
121747	2216	do	do	♂ adult; perfect	Do.
115605	1884	<i>G. volans</i>	Rhio Arch., Pulo Bintang.	♀ adult; perfect	W. L. Abbott, 1902.
143327	4704	<i>Cyanocephalus</i> sp.? (<i>Galeopte- rus</i>).	E. Sumatra, Pulo Rupat.	(?)	W. L. Abbott, 1906.
143325	4696	<i>Galeopterus</i> sp.? (<i>Cyanocephalus</i> .)	do	♀ adult; good	Do.
114376	1460	<i>Galeopithecus</i> <i>tuancus</i> .	Banjak Islands, Pulo Tuangu.	♂ adult	W. L. Abbott, 1902.
121853	2353	<i>Galeopithecus</i> <i>saturatus</i> (<i>Galeopithecus</i>).	Batu Islands, Pulo Pincee.	do	W. L. Abbott, 1903.
121854	2351	do	do	do	Do.
3780 3940		<i>Galeopithecus</i> <i>volans</i> .	Singapore, Ma- lay Peninsula.	Not given	Explor. Exped.

Skulls of Malayan species, United States National Museum—Continued.

U. S. Nat. Mus. number.	Original number.	Name.	Locality.	Sex, age, etc.	Collector.
3785		<i>Galopithecus volans</i> .	Singapore, Malay Peninsula.	Not given	Explor. Exped.
3946				do	Do.
3784				do	Do.
3945				do	Do.
122766		<i>Galopithecus</i> sp.?	Malay Peninsula, Pinic.	do	W. L. Abbott. Parietals dented, killed with blow.
115493	1838	<i>G. volans</i>	Rumpin R., Pahang.	♂ adult	W. L. Abbott, July, 1902.
122385	2521	<i>Galopithecus</i>	E. Sumatra, Pulo Kundur.	♀ adult; mandible broken.	W. L. Abbott, July, 1903.
49693		<i>G. volans</i>	E. Sumatra, Pulo Kundur.	♀ adult; perfect.	W. L. Abbott, 1903.
86786		do	Troung, Lower Siam.	do	W. L. Abbott, 1899.
84420		do	do	do	W. L. Abbott, Mar. 5, 1897.
84421		do	do	♀ young; somewhat broken.	W. L. Abbott, Mar. 4, 1897.
86787		do	do	Sex not given; young.	W. L. Abbott, Mar. 4, 1899.
83276		do	do	♂ subadult	W. L. Abbott, Mar. 1, 1896.
151887	5701	<i>Galopithecus</i> sp.?	Pulo Sebuku	♂ adult	W. L. Abbott, 1897.

Skull.—Taking the series as a whole (Malayan and Philippines) and viewing the skull from above there are a number of points of difference worthy of notice, and these apart from the matters of sex and age. On this view any Philippine Islands specimen can be distinguished at once from any of the Malayan forms by the character of the nasomaxillary arch, taken transversely from alveolar process of one side to the one on the opposite side and including all the region anterior to the orbits. In the Philippine forms this is very broad and rounded; the nasals more or less lying in the same surface; while on transverse section here the line of the curve is circular. In the Malayan forms this region is narrower; as a rule, more acute, and the nasals more in evidence, and raised above the general surface for their entire lengths. In old individuals these bones in all forms (Malayan and Philippines) fuse completely with the bones they articulate with in the face.

In the Malayan forms the superior produced arches of the orbital peripheries are more elevated and, as a rule, much broader than they are in any of the Philippine forms. In all species, the orbital cavity is strikingly circular in outline, with the plane of its margin looking forward, outward, and slightly upward; its cavity, everything else being equal, being markedly greater in the Malayan species than it is in any

of the specimens from the Philippine Islands, at least one-third larger on comparing skulls of equal size. (As 144655 ♀ Basilan Island and 84420 ♀ Trong, Lower Siam.) This character is constant and eminently distinguishing.

One of the most interesting characters on this superior view of the skull is the variation in the extent of the area of the temporal fossæ, and the fact as to whether or not they meet in the median line posteriorly, and to what extent, if they do meet. This character I have carefully examined in the 52 skulls at hand belonging to the National Museum and the Bureau of Science, and in the few skulls of my own collection. On any specimen the surface of one of the temporal fossæ, selecting either side, may be more or less rough. In all forms these areas are very distinctly defined, with the limiting boundary line more or less raised. Now in no Malayan form of flying lemur do the temporal fossæ at all approach each other posteriorly: the interval often being nearly one centimeter in adult skulls of either sex. This appears to be the case with the young of *Cynocephalus* (number 144661 ♀) and still more marked in the young of *Galeopterus*.

Among the Philippine forms this character varies, though in none of them do the temporal fossæ ever approach each other anywhere as closely as in any of the Malayan forms.

Referring to the numbers in the above tables for the specimens and their localities the following are found to be the intervals between these fossæ. In number 144663 it could not be determined as the skull is too much broken up. Of all the skulls from the Philippines the contact is most extensive in number 144655 where the internal margins of the fossæ come in contact for one centimeter, their common borders forming a distinct crest, which extends posteriorly to the occipital crest. In numbers 123422 and 144656, where it is about equal, it is less extensive, the median crest is less pronounced and does not extend to the occipital crest. The contact is slightly less in number 144658. In numbers 144657 and 144659 there is an interval of one millimeter, and in number 144660 about two millimeters. The greatest interval is seen in skull number 106 where it is equal to the interval in the Steere specimen in my own collection, that is five millimeters; it is slightly less in number 108, and still less in 105 and 111, the interval still being from one to two millimeters. As a rule, then, the approach of the temporal fossæ, posteriorly, is likely to be far more extensive in Basilan specimens than in those from Bohol; in the latter they are rarely, if ever, in actual contact.

Turning to the base of the cranium we find the palatal region, or roof of the mouth, comparatively broader and much more in front in the Philippine specimens than in any of the Malayan species; the tympanic bullæ are much better developed and have thinner walls in the latter than

in any of the skulls from the Philippines. Posteriorly, we find that the form of the occipital area varies to some extent, though as a rule it is lower and more rounded superiorly in skulls of *Cynocephalus* than in any of the others. In the Malayan skulls it tends to become more lofty and oblong in outline, its width averaging nearly double its height.

In *Cynocephalus* the mandible is as a rule, in specimens of the same age and sex, a considerably stronger and deeper bone than in any of the Malayan species. (Compare numbers 121749 and 168.)

Mr. Gerrit Miller has pointed out to me the fact that the milk teeth in Philippine forms (*volans*) more or less resemble the permanent teeth in any of the Malayan species. This is well seen in two skulls prepared for the purpose, namely, number 121854 ♂ (Malayan) and number 105 ♂ from Bohol. To compare all the dental characters would require too much space here. They vary in the two genera and in old age wear down considerably.

Trunk skeleton.—Passing to the trunk skeleton it is to be noted that apart from the fact that all flying lemurs possess 7 cervical vertebrae, and as a rule 13 dorsals, they may vary very decidedly in the number of the lumbar vertebrae, as the following table tends to show.

Vertebrae in Galeopteridae.

Specimen.	Number of vertebrae.		
	Cervical.	Dorsal.	Lumbar.
McGregor specimen in personal collection	7	13	7
No. 49640, National Museum, ad. ♀	7	13	6
No. 154600, National Museum, juv.	7	13	5

* The 13th supports a pair of free ribs.

Moreover, the characters of some of the vertebrae are different, as for instance, in the atlas. In *Galeopterus* (number 49640) this bone is nearly square in outline, and possesses a fairly well developed neural spine, situated anteriorly. There is no evidence whatever of such a spine in the atlas of *Cynocephalus*, in which genus this vertebra is very much wider transversely than it is longitudinally. The transverse processes of the lumbar vertebrae in *Galeopterus* (number 49640) are strongly developed, in every case springing from the entire side of the centrum, and are directed outward and forward. They are much smaller in the Steere specimen (*Cynocephalus*), and in the specimens of this genus sent by McGregor from the Philippines they are nearly entirely absent. Some unimportant differences are seen in the sacral and caudal vertebrae of the specimens here under consideration and, everything else being equal, the ilia of the pelvis in *Cynocephalus* are longer than in the Malayan species.

Limbs.—The comparison of the bones of the limbs, although made with care, need not be entered upon to any extent in the matter of description. In the main the long bones are very much slenderer in *Galeopterus* (number 49640) than they are in the specimen of *Cynocephalus* collected by Steere, while they vary very little in their lengths. This is especially well seen in the humeri and in the femora.

In the forearm of *Galeopterus* the radius and ulna still remain distinct in the adult, though the ligamentous union is very close, and in very old animals it is just possible that coössification may take place distally between these two bones. It is fair to presume that for this character Owen, Huxley, and Flower examined old adult specimens of some Malayan flying lemur in the collection of the British Museum or at the Royal College of Surgeons and that without forcing maceration far enough to separate the bones, they came to the conclusion that osseous union had taken place between the radius and ulna distally. Mr. Gerrit Miller was kind enough to examine this character with me, and even went so far as to macerate for several days the forearms of the old *Galeopterus* and the young one in the National Museum collection, and became convinced of the above facts as here set forth.

The scapulæ and clavicles of these two genera are quite similar, and in animals of the same age the differences are scarcely noticeable.

ILLUSTRATIONS.

(From photographs by the author.)

PLATE III.

- FIG. 8. Left lateral view of the pelvis of *Cynocephalus*, natural size, and from the same adult specimen which supplied the bones shown in figures 3 to 7. The leading vertebra shown in this figure is the last or eighth lumbar vertebra.
9. Antero-external aspect of the left radius and ulna of *Cynocephalus*; slightly enlarged and from the same specimen as before, figures 3 to 8. This figure shows the ligamentous attachment of the ulna to the radius. The bones are somewhat pulled apart at their proximal extremities.
10. Ventral view of the first cervical (atlas) vertebra of *Cynocephalus*, adult, natural size and from the same specimen, figures 3 to 9. This is a direct view and the extremity of the bone that articulates with the skull is faced toward the top of the plate.
11. Direct left lateral aspect of the second cervical (axis) vertebra of *Cynocephalus*. From the same specimen from which the other bones were obtained, figures 3 to 10.
12. Direct ventral view of the five caudal vertebrae of *Cynocephalus* (being the fourth to the eighth inclusive), natural size and from the same specimen, figures 3 to 11. When articulated in the skeleton the first three of these vertebrae are between the pelvic bones, the distal extremity of the third being exactly opposite the posterior ischio-iliac border.

PLATE IV.

- FIG. 13. Lumbar vertebrae of *Cynocephalus*, being the third to the seventh inclusive and seen upon direct dorsal view. Slightly reduced and the same bones as those shown in figure 7 of Plate II. The seventh lumbar is toward the top of the plate.
14. Direct ventral view of the pelvis of *Cynocephalus*; slightly reduced and the same bone as shown in figure 8 of Plate III. The vertebra in front of the sacrum is the eighth lumbar.
15. Outer aspect of the left humerus of *Cynocephalus*, very slightly enlarged. At the distal end the supracondyloid foramen is partly in view. From same specimen as before, figures 3 to 14.
16. Right humerus of *Cynocephalus*; direct view of posterior surface, and the bone very slightly enlarged. From the same skeleton from which the one in figure 15 was taken.

PLATE V.

- FIG. 17. Right lateral view of the trunk skeleton of *Cynocephalus*, reduced about one-third. Skull removed. This is from one of the skeletons sent from the Bureau of Science. Some of the dried ligaments have not been removed, especially in the cervical region. Spinal column complete. The skull of this specimen is shown in figure 2 of Plate I.

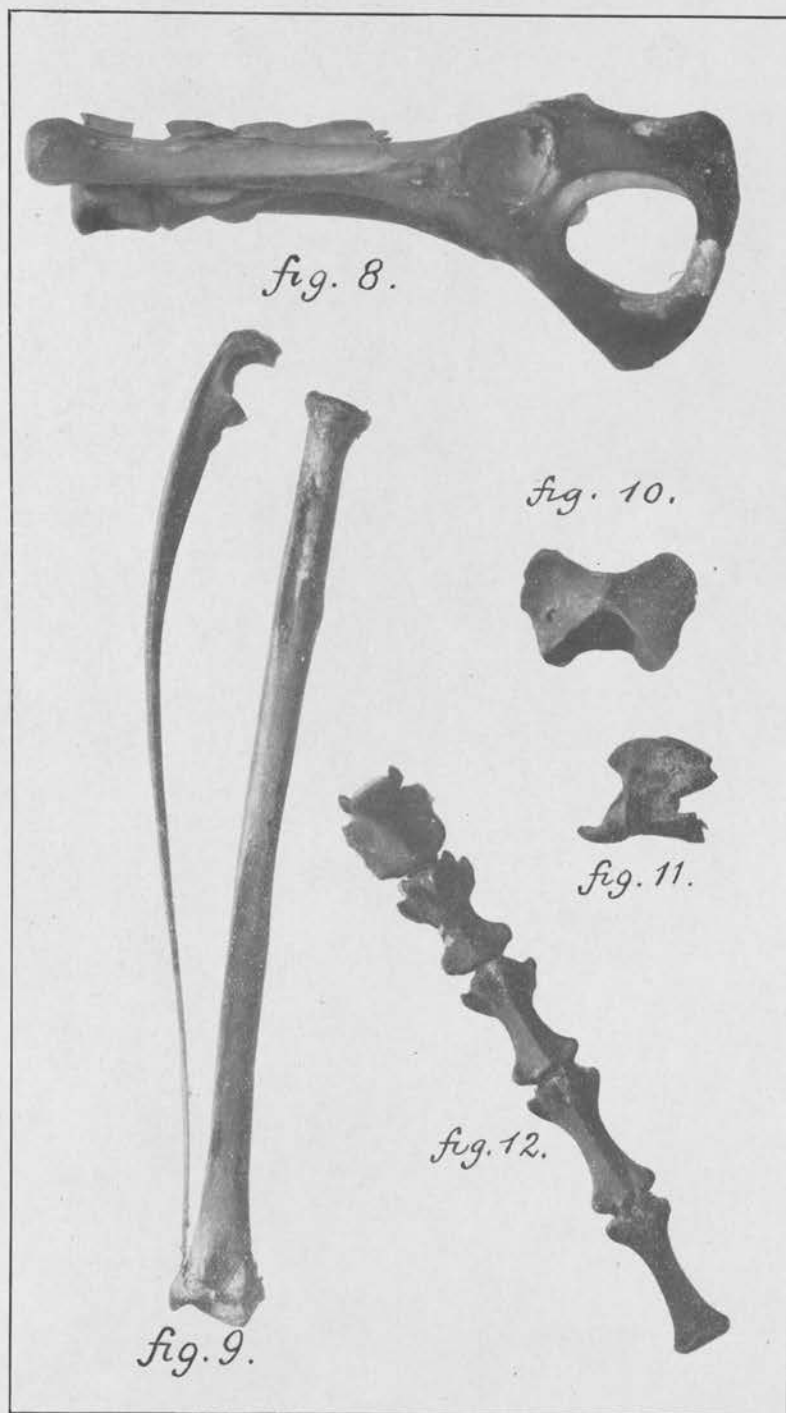


fig. 13.



fig. 14



fig. 15.



fig. 16.



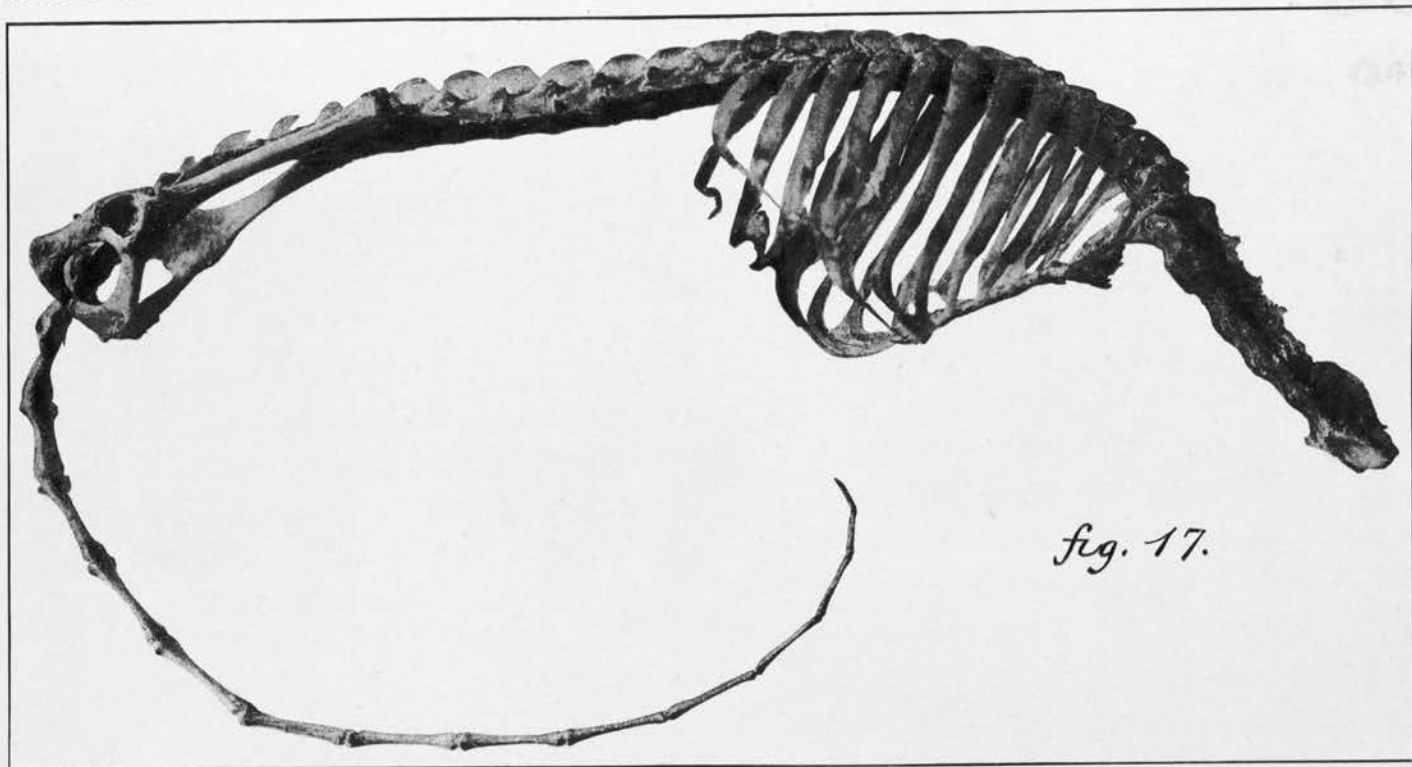


fig. 17.

ON THE HABITS OF *THALASSINA ANOMALA* (HERBST).

By A. S. PEARSE.¹

(From the Zoölogical Laboratory, University of the Philippines.)

Although *Thalassina anomala*, as Bate² (p. 27) says, is of particular interest because it "supplies a link connecting the macrurous with the anomurous Crustacea," but little has been learned concerning its habits. Again quoting from Bate:

"We do not know much of the habits of this animal, but many of the group are burrowers in the deposits beneath the seas in which they live, hence it is more than probable, from the matted condition in which I found the fur that covers many parts of the animal, that it inhabits hollow passages in the mud, and that the circulation of the water through the branchial chamber can not be very vigorous * * *." He believed that the structure of the branchiæ showed that they were capable "of extracting oxygen from water that had been stored for a long period where it has not been affected by the atmosphere."

This peculiar crustacean probably occurs throughout the Philippine Islands. Dr. L. E. Griffin informs the writer that it is common in Oriental Negros, and it is abundant along the estuaries of Manila Bay. In the latter locality it is called *palatak* by the Tagalogs. During the months of May, June, and July, 1911, the writer made many observations on its habits and ascertained that, though Bate's² plates of this animal were very inaccurate, his conjectures concerning its habits were in general correct. Though it may burrow "in the deposits beneath the seas," along Manila Bay the mounds of earth (fig. 1) brought out at the opening of its burrows are found at the edges of estuaries near or above the usual high tide mark.

Thalassina burrows with the first legs, the dactyls of these appendages being used somewhat like trowels to pull the dirt loose. The animal works a load free and then carries the mass before it to the mouth of the burrow. The load is carried in the first legs between the dactyl and the propodus, and it may also be supported below to some extent by the second legs which are held in a horizontal position. The first two pairs of legs form a sort of a basket which is an admirable instrument for sweeping all loose mud before the animal as it moves through its

¹ Assistant Professor of Zoölogy, University of the Philippines.

² Bate, C. S. 1883. Report on the Crustacea Macrura dredged by H. M. S. Challenger during the years 1873-1876. Challenger (1888), 24, 27.

burrow. The loads of mud are dumped at the mouth of the hole, the first legs being stretched forward while the sticky mass is pushed from them with the second legs. Where the burrow opens above high tide mark the dirt often accumulates and forms a tower, like that shown in Plate I, which may sometimes be nearly one meter in height.

The opening of a burrow is usually closed when it is not being used. On July 4, the writer while sitting within two feet of the *Thalassina* tower shown in Plate I saw its owner "close up" for the day. This individual had apparently been digging actively during the night, for a lot of fresh mud had been thrown over the side of the mound. Soon after 10.00 o'clock in the morning he pushed a mass of mud out to within about 12 millimeters of the open mouth; before 10.42 he had brought two similar loads, the first of which was deposited beside the earlier one. As he carried up the last load the whole mass of fresh mud was pushed up from below so that the top of the tower assumed a more or less rounded contour. When a *Thalassina* opens a burrow that has been plugged he does not always choose the same place and may leave the old exit as a blind passage; this is particularly true of burrows in the softer grounds that are covered by the tide (text fig. 2). On the other hand, holes dug in the hard clay of grassy meadows (text fig. 1) often go nearly straight down until they are below water level. Every burrow explored by the writer was of sufficient depth to have standing water in its deeper portions so that it was impossible to follow it on account of the rapidity with which water seeped in.

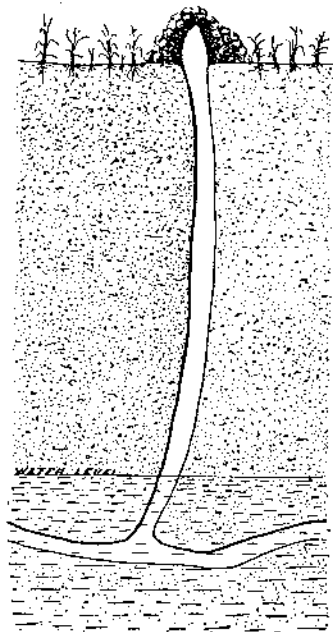


FIG. 1.

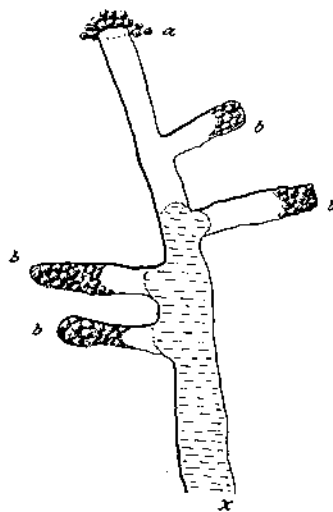


FIG. 2.

Through the study of the structure of preserved specimens, Bate surmised that *Thalassina* was able to live in poorly aerated water, and its habits are such that this ability would often be of advantage. It possesses an adaptation that is probably for this purpose, that is, the branchiostegites are movable on the dorsal portion of the carapace by a sort of flexible hinge-joint. An individual placed in a dish will often move the sides of the carapace in such a manner that it resembles a vertebrate gasping for breath. Such movements would serve to clear the water quickly from the branchial chamber.

Judging by an examination of the stomach contents of a medium sized female captured at 11.00 in the morning of July 20 and examined about two hours later, *Thalassina* is a vegetarian. This stomach contained a little fine silt, many bits of vegetable tissue (apparently largely from the stems of vascular plants), a root tip, and a small grass plant bearing several leaves and roots. These things indicate that the food came largely from the pasture land at the edge of the estuary, for the most careful examination failed to reveal any algae. Algae are always abundant in the stomachs of the fiddler crabs that dig their holes beside those of *Thalassina* and feed over the wet mud-flats during the day.

The *Thalassina* is extremely shy. Most of its burrows are closed during the day, but more of them are open on rainy or cloudy days than when the weather is clear. When handled or placed on the ground this crustacean is slow moving and cautious rather than pugnacious, attempting to hide or to creep away. It is apparently nocturnal or becomes active in the twilight, for fresh mud is usually seen at the mouth of burrows in the morning, rarely in the afternoon. Though *Thalassina* depends largely on its secretive habits to protect it from its foes, once it is in the hand of its enemy the many spines on the surface of the body and legs form an admirable adaptation for escape. Those on the body all point toward the anterior end and when in the grasp of an enemy serve to prevent the body from slipping forward but facilitate movement in the opposite direction. It is surprising how hard it is to hold an animal that pushes your hand forward frantically with its legs; the spines do not allow the fingers to regain their hold easily. Hence *Thalassina* often slips to the ground and backs into the nearest burrow.

The Filipinos assert that the *palatak* makes sounds, and they attempt to imitate them by making a popping noise with the tongue, similar to that made by the cork of a beer bottle as it is withdrawn. The writer has often heard such sounds when among the *Thalassina* burrows, and has produced a similar sound by rubbing that animal's first leg along the curved row of spines on each side of carapace, but has never seen this species stridulate.

ILLUSTRATIONS.

PLATE I.

Shore of an estuary showing a mud tower raised by a *Thalassina* over the mouth of its burrow.

TEXT FIGURES.

- FIG. 1. Section to show the plan of a *Thalassina* burrow excavated July 4.
Distance from surface of ground to bottom of burrow about 1.2 meters.
2. Diagram showing a plan of the mouth of a *Thalassina* burrow excavated July 2; the distance from *a* to *x* was about 0.75 meter, the depth at the water level, 0.30 meter below the surface of the ground. *a*, open entrance; *b*, closed entrance.



PLATE I.

CONCERNING THE DEVELOPMENT OF FROG TADPOLES IN SEA WATER.

By A. S. PEARSE.¹

(From the Zoological Laboratory, University of the Philippines.)

It has long been believed that amphibians are unable to withstand salty water. Gadow² says:

Common salt is poison to the Amphibia; even a solution of 1 per cent prevents the development of their larvae. Consequently seas, salt lakes, and plains encrusted with saline deposits act as most efficient boundaries to normal "spreading."

Some observations at Manila during the summer of 1911, which show that certain frogs live and breed along the swampy edges of estuaries where the water is almost as saline as that of the ocean itself, are of interest in this connection.

During the month of May, the writer had occasion to spend many quiet hours along the edge of an *estero*³ not far from its opening into Manila Bay. He was struck by the fact that frogs were often seen to hop about on the flats at low tide and to dodge into the crab⁴ holes filled with salty water. Four of these frogs captured on July 13 were all referable to the genus *Rana* and, though they apparently belonged to a single species, it could not be determined with the literature at hand. They were all small, measuring respectively 35, 34, 32, and 18 millimeters in length.

On June 17, at 8.30 in the morning the writer observed that two crab holes at the edge of the *estero* were filled with a wriggling mass of newly hatched frog tadpoles. These holes had been seen to be left above low-tide mark with water standing in them and to be covered by water at high tide on each of the three days previous. On the date mentioned, they were submerged by the advancing tide at 8.30 in the

¹ Assistant Professor of Zoology, University of the Philippines.

² Gadow, H. *Cambr. Nat. Hist.*, London (1901) 8, 72.

³ An *estero* is a small creek into which the tide flows.

⁴ *Scorpa hideos* (de Haan).

morning and the tadpoles streamed from them into the salty water; at 9 o'clock a tadpole was seen swimming 6 meters from the hole where it hatched. At 2 o'clock in the afternoon, after the tide had begun to ebb, a sample of water was taken directly over the holes where the tadpoles had been observed in the morning. This was analyzed by Mr. V. Q. Gana of the Bureau of Science and found to contain 18.7 parts of chlorine per 1000, the equivalent of 26.44 grams of sodium chloride per liter, or a 2.64 per cent solution. These frog tadpoles, then, apparently developed in crab holes that were left exposed at every low tide and covered by 30 and 60 centimeters of water respectively at high tide.

On July 6 samples of water were collected from two pools, on the edge of the *estero*, both of which contained tadpoles. The dimensions of the first pool were about 2.5 by 2 meters. This pool was connected with the main *estero* by a narrow ditch, so that the two communicated at high tide. The second pool was larger, being about 10 meters square and though it was connected with the *estero* by a ditch, was not flooded with salt water so often because it was on a higher level. The tadpoles taken from the first pool were nearly ready to metamorphose into frogs and had well-developed legs; those from the second pool had been hatched only two or three days. Mr. Gana's report on the amount of chlorine per liter was as follows:

	Grams.
Sample from first pool	14.851
Sample from second pool	7.920

The tadpoles in the former, therefore, were living in a 2.096 per cent solution of sodium chloride; those in the second pool in a 1.124 per cent solution of the same salt.

The observations described show that amphibian tadpoles developed in slightly diluted sea water, containing as high as 2.096 per cent of sodium chloride and make it seem probable that the same thing occurred in a 2.644 per cent solution.

REVIEWS.

The Biological Stations of Europe. By Charles Atwood Kofoid. United States Bureau of Education Bulletin No. 4, 1910. Illustrated. Pp. xiv-360.

This bulletin of the United States Bureau of Education is a most welcome and opportune volume. It forms a splendidly illustrated book of 360 pages, conveniently arranged and indexed. Doctor Kofoid has based his report largely upon a personal visitation and investigation of the fresh water and marine biological stations of Europe and the results of personal knowledge are plain throughout the work. Every American biologist should possess and make a careful study of this book, not only because of the descriptions and photographs of the stations, with detailed plans of buildings, aquaria, and fixtures which are presented, but also because the practical objects to be attained through biological stations are clearly stated. In the mind of the American public and, it is to be feared, in the minds of most biologists also, biological stations are considered as educational luxuries, not as economic and scientific interests of the nation. If he does not look upon them as pleasant summer resorts for teachers and students, the biologist is still quite apt to consider that they should be laboratories for research in pure science. One does not need to be a prejudiced admirer of all things German in order to recognize the value of the different attitude of the middle European countries toward the function of biological stations; it is in Germany and Austria-Hungary that they are performing their most noteworthy economic work. Stations for the investigation of pond culture of fishes and crayfish; of river and lake life; of the control and biological utilization of sewage; of the effect of sewage and chemical by-products upon the animals inhabiting rivers and for the active control of evils arising from these causes, do not lessen the scientific activities of their workers but rather increase them, by giving definite aims and purposes to the researches.

According to Doctor Kofoid's report, there exist in Europe 85 biological stations, of which 27 are located on fresh-water. The distribution is worth noting. Italy has 4, France and Monaco 20, Great Britain and Scandinavia 12 each, Germany and Austria-Hungary 10 each, Holland and Finland 3 each, Russia 7, Spain 2, Belgium and Bulgaria 1 each. The disparity between the number of biological stations in Germany and France is superficial, for it must be remembered that Germany is largely

the supporter and founder of that at Naples, while one of the best of the French stations, Villefranche, is related to, although not under, the administrative control of the University of Kief of Russia. The geographical location of the seashore of Germany has turned a very considerable number of the biological students of Germany to the Naples station, while the French students have been able to seek work on their own more favored coast. This is indicated by the list of the attendance at Naples, which Dr. Kofoed gives by countries during the years of 1873 to 1909. Out of 1,934 occupants of research tables, Germany furnishes the largest number, namely, 630, while France furnishes but 4. The United States is sixth in this list of countries.

The report deals very clearly with the economic or applied scientific activities of the biological stations. One particularly valuable feature lies in the statements made of the objects which certain stations are attempting to accomplish, and the lines of investigation which are being followed.

The distribution of the fresh water stations, and their numbers in the various countries as compared with the marine stations, is significant both of the geographical location and of the economic interests of these countries. In France four out of 20 stations are fresh-water. In Great Britain but one out of 12, in Germany and Austria-Hungary, each, six out of 10, in Scandinavia four out of 13, in Finland two out of 3, and in Russia three out of 7.

Thirty-nine of the 85 stations, may be termed independent; that is, they are supported either by private individuals or by societies, or by local societies in conjunction with private persons and are not controlled by the government or by a university. Nearly all of these independent stations receive grants of money from their respective governments but without being brought thereby under governmental control. It is significant that these independent stations on the whole, include, the finest of all, such as that at Naples, the Institute of Oceanography at Monaco, the Plymouth Marine Biological Stations, and stations of the Liverpool Marine Biological Committee.

Twenty are supported by universities, generally as coördinate divisions of the Zoological departments. The development of the university biological stations in France is noteworthy in contrast with other European countries, for 13 are related to French universities while a fourteenth, that at Villefranche, is related to the Russian University of Kief. In Germany and Austria-Hungary but a single university possesses its own zoological station. This is no doubt to be explained by the fact that the governmental department of public instruction to a large extent controls and supports all of the stations of these countries.

There are thus remaining 32 stations in Europe which are directly supported by governmental agencies. All of these and about half of the

first group are primarily engaged in economic biology. The short histories of the development of each of the more important stations form a particularly interesting feature of Doctor Kofoid's book, and one which will be greatly appreciated by his readers.

LAWRENCE E. GRIFFIN.

The Racial Anatomy of the Philippine Islanders. Introducing new methods of anthropology and showing their application to the Filipinos, with a classification of human ears, and a scheme for the heredity of anatomical characters in man. By Robert Bennett Bean, B. S., M. D. Cloth. Illustrated. Pp. 236. Price \$2, net. Philadelphia & London: J. B. Lippincott Company, 1910.

The author's thesis is admirably set forth in the preface as follows:

"This book represents studies of the human form rather than the skeleton, and embodies the results of three years' investigation of the Filipinos. A method of segregating types is introduced and affords a ready means of comparing different groups of men. The cephalic index is established as a differential factor in racial anatomy, the ear form becomes an index of type, and other means of analyzing random samples of mankind are presented for the first time. The book, therefore, represents a new departure in anthropology, and the term racial anatomy of the living is not inappropriate as a title. Approved methods of the Old World have been utilized, and it is to be hoped that this contribution from the New World will be received with due consideration as a striving after truth. * * * The object of this book is to establish definite types of man that may be recognized by ear form, cephalic index, nasal index, and other factors, that such types may be studied in families through several generations to establish their hereditary characteristics, and this is the author's reason for the present publication."

The conclusions arrived at may be divided into three very distinct classes: I. Those relating to *methods* of physical anthropology;¹ II. A new classification of the whole human race, based upon the results of the new methods employed; and, III. The classification and correlation of the people of the Philippine Islands.

CLASS I. *Old methods of somatology*: The cephalic index has long been held to be the most permanent physical characteristic of man. Doctor Bean throws grave doubt on this assumption, affirming that the manner of sleeping seriously affects the shape of the head. This is particularly true in the Orient where the Chinese sleep on porcelain beds, the lowland Malays on mats laid upon the floors, and the mountain peoples on sleeping-boards of hard wood. However, Doctor Bean uses the cephalic index in his work, as well as the nasal index, facial index, height, reach, and other anthropometric measurements in common use by somatologists. 2. *New methods of somatology*: Two entirely new factors in the deter-

¹ It is to be regretted that the author does not use the more precise term "somatology," now in general use by leading anthropologists.

mination of physical type are introduced by Doctor Bean, namely, Ear Type and The Omphalic Index.

"Types of human ears are established for the first time, and each ear type is associated with a physical type of man. * * * The types of ears not of European origin are morphologically older than the European ears. The Spanish population of Manila has ear types which are closely simulated by the European types among the Filipinos. * * * Ear type seems to be independent of pigmentation to some extent, because the same type of ear is found on blond and brunette Europeans, on dark-skinned and light-skinned Filipinos, and on dark-skinned Indians and light-skinned Chinese."

One of the most important factors in favor of ear type as a means of somatological classification is that it is so little modified by natural selection. The Omphalic Index is described by the author as follows:

"The position of the umbilicus in relation to the pubis and the suprasternal notch, although it is more variable than the two points last mentioned, is of importance in the differentiation of the species of men. * * * The index is found by dividing the distance of the umbilicus from the pubic spine by its distance from the suprasternal notch. This indicates its relative position on the body. If the index is high, the umbilicus is relatively near the suprasternal notch, but if low, it is relatively near the pubic spine. I propose the name of Omphalic Index for the index of the umbilicus."

CLASS II. From a study of the measurements of 2,500 white Americans, 100 American negroes, 1,500 lowland Filipinos (chiefly Tagalog), and 104 Igorots of Benguet and Bontoc, together with various smaller numbers of published measurements of Russians, Siberians, Chinese, Japanese, etc., the author finds but three systematic species of the genus *Homo*. These he names Iberian, Australoid, and Primitive. The Iberian is the fundamental European type, the Australoid the fundamental negroid type, and the Primitive the fundamental type of the Orient and of the Pacific peoples. But among all races, and in all countries of the world thus far examined, all three types are to be found in varying proportions.

"Among Europeans the other types resemble the Iberian; among negroes the other types resemble the Australoid; and among Orientals the other types resemble the Primitive. The composition of any group of people, large or small, depends on the relative proportions of each type that entered into the composition of the group, the time during which the types have been in contact, the conditions of food, water, air, habits, etc., and other factors. There is no evidence that any type of man that ever existed has disappeared entirely,* although there is evidence that the types have become somewhat modified in different parts of the world."

CLASS III. In his study of the people of the Philippines Doctor Bean finds the three systematic species already mentioned, and these he further divides into twelve varieties, viz., Iberian A, B, C, D, Primary and

* In connection with this statement attention might be called to the Tasmanians, as a possible exception.

Secondary Australoid, Primitive, Modified Primitive, Blend (?), and Adriatic. In addition to these varieties he finds four further types, the Cro-Magnon (?), B. B. B. (?), Australoid, and Alpine, which he considers are elementary species being at present developed from amalgamation of various combinations of the above varieties.

"The word Malay has been avoided purposely so far because I have been unable to decide to my own satisfaction what is the Malay type, if there is such a type. My opinion is that the Malay is a composite of the Iberian from Europe, the Primitive from Asia, and the Australoid from its primary center, wherever that may have been. * * * If the Australoid and Primitive types represent the original elements of the Filipinos, and the other types represent modifications caused by Europeans and Chinese, recent and remote, then the individuals of the present population are larger than the original in all physical characters. Continued immigration, with consequent interbreeding of Americans and Chinese with the Filipinos, will result in further increase of size. With increase of size go increase in bodily and mental vigor. Advance on the part of the Filipinos will be coincident with and incident to the continuation of the amalgamation of the races, although better nutrition, fewer animal parasites, and improved hygiene may assist in the advance."

An appendix is added to the book giving a detailed description of Doctor Bean's *Homo philippinensis*. Only a single specimen is described, and it would seem that we should await the evidence of further research in the Philippines, and in the East Indies generally, before ascribing much importance to this type.

In Chapter VII, "The Relation of Morphology to Disease," the author attempts to show that tuberculosis in the Philippines is confined almost exclusively to individuals of the Iberian type. He also holds that the Iberian is more susceptible to all diseases than is the Primitive. As all of the persons examined were from Manila, or the immediate vicinity, it would be interesting to have further data on this point gathered from other parts of the Islands.

Though several leading anthropologists have, within recent years, arrived at conclusions similar to those of Doctor Bean with regard to the classification of the human race, and as to the compound nature of the type formerly known as Malay, yet no one, within the knowledge of the reviewer, has set down his conclusions so clearly and definitely as has the author of the book under consideration. It may safely be predicted that the work of Doctor Bean will give a great impetus to further investigation along the lines suggested, and, whether his striking conclusions be justified or not, the result will be a distinct addition to the sum of our knowledge regarding the origin and development of the present existing peoples of the earth. It may well be that it will give us some insight also into what will be the future effect of the general amalgamation of races that is now so universally taking place.

The typography of the book, and the illustrations, mostly from photos by Worcester and Martin, are excellent, although there is certain evidence

of a too hasty reading of the proof. A little care would have eliminated such errors as that on page 144, where Fr. Joaquín Martínez de Zúñiga's "Estadismo de las Islas Filipinas" is cited as "P. Martinez makes the statement in his book 'Estadismus de Filipinas,' etc."

In explanation of the absence of references the author says:

"No attempt has been made to give references to the literature, because references have been given already in the *Philippine Journal of Science*, where the original monographs of the author covering a part of the subject matter of this book have appeared from time to time during the past few years."

In conclusion, attention may be called to two recent papers³ in which Doctor Bean gives the results of some further investigations, and sums up his conclusions with even greater clarity than in the book itself.

Regardless of the effect of future investigations upon his conclusions, the work of Doctor Bean marks a distinct step in advance in the science of somatology.

H. OTLEY BEYER.

³ *Am. Anthropol.* (1910), 12, 220-236; *Ibid.* (1910), 12, 377-389.

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By CHARLES S. BANKS.

(Publication of the Bureau of Science.)

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